NOV 11 1935

MEDICAL LIBRARY

VOLUME 31 NUMBER 5

# ARCHIVES OF SURGERY

EDITORIAL BOARD

DEAN LEWIS, Baltimore

EVARTS A. GRAHAM, St. Louis
WALLACE I. TERRY, San Francisco

ALTON OCHSNER, New Orleans
WILLIAM DARRACH, New York

EDWARD STARR JUDD, Rochester, Minn.

NOVEMBER 1935

PUBLISHED MONTHLY BY AMERICAN MEDICAL ASSOCIATION, 535 NORTH DEARBORN STREET, CHICAGO, ILLINOIS. ANNUAL SUBSCRIPTION, $8.00

Entered as Second-Class Matter, July 10, 1925, at the Postoffice at Chicago, Illinois, Under the Act of March 3, 1879. Acceptance for mailing at special rate of postage provided for in Section 1103, Act of Oct. 3, 1917, authorized July 29, 1920.

## CONTENTS OF PREVIOUS NUMBER

### OCTOBER 1935. NUMBER 4


Fascial Sarcoma and Intermuscular Myxoliposarcoma. James Ewing, M.D., New York.

Anal Ducts: Comparative and Developmental Histology. Claude C. Tucker, M.D., and C. Alexander Hellwig, M.D., Wichita, Kan.

Fibrosarcoma of the Right Forearm with Extensive Growth into the Cephalic Vein. George G. Davis, M.D., Chicago.

Clinical and Histologic Changes Produced in Carcinoma of the Cervix by Different Amounts of Roentgen Radiation: A Comparison. A. N. Arneson, M.D., and Fred W. Stewart, M.D., New York.

Longitudinal Growth of Long Bones. J. Dewey Bisgard, M.D., and M. E. Bisgard, B.A., Omaha.

A Clean Intestinal Anastomosis: II. An Experimental Study. Edgar J. Poth, M.D., San Francisco.

The Pendulous Hypertrophic Breast: Comparative Values of Present-Day Methods of Repair and the Procedure of Choice. Jacques W. Maliniak, M.D., New York.

Multiple Meningiomas: Report of a Case in Which Three Intracranial Meningiomas Were Removed Successfully. John E. Raaf, M.D., and Winchell McK. Craig, M.D., Rochester, Minn.

Acute Abdominal Pain in Sickle Cell Anemia. Eldridge H. Campbell Jr., M.D., Albany, N. Y.

Changes Produced by Various Operations on the Stomach Shown by the Use of a Modified Acid Test Meal. Frederick C. Hill, M.D.; Leo C. Henrich, M.D., and Charles M. Wilhelmj, M.D., Omaha.

Fatal Cases of Septicemia Caused by Bacillus Coli Following Gastric Operations. Fred W. Ilfeld, M.D., Cleveland.

Experimental Staphylococcic Suppurative Arthritis and Its Treatment with Bacteriophage. George Albert Lake Inge, M.D., Sc.D. (Med.), and James William Toumey Jr., M.D., Sc.D. (Med.), New York.

Effect of Diet on Weight of Liver and Glycogen Concentration in Partially Hepatectomized Rats. Caleb Smith Stone Jr., M.D., Santa Barbara, Calif.


COPYRIGHT, 1935, BY THE AMERICAN MEDICAL ASSOCIATION

ARCHIVES OF SURGERY

VOLUME 31 NOVEMBER 1935 NUMBER 5

# PATHOGENESIS OF FIBRO-ADENOSARCOMA OF THE BREAST

ROBERT C. GRAUER, M.D.

AND

GEORGE H. ROBINSON, PH.D.

PITTSBURGH

The study of tumors of the breast has given rise to many controversial points both as to their origin and as to the predisposing factors in their development. This has been especially true in the case of epithelial tumors. On the other hand, those arising from connective tissue and falling into the category of sarcomas have been neglected because of their rarity and also because of the unsettled state regarding their classification. An unusual opportunity is afforded the investigator attempting to elucidate the question of the relationship between the epithelial and the connective tissue elements in neoplasms of the breast by studying the group classified either as adenomas or as adenofibromas. In this group of tumors of the breast, actively proliferating periductal and periacinal fibrous tissue, which differs from the connective tissue elsewhere in the breast, as well as hyperplastic glandular structures, is present.

In this paper we are using the terms adenoma and adenofibroma interchangeably, and we are concerned only with the definitely encapsulated tumor nodules that can be shelled out and that do not necessarily represent areas of abnormal involution. We consider this an important differentiation, as areas of abnormal involution occur in lactating breasts or may be attendant on the cyclic changes occurring during menstruation. It appears to us that such areas do not represent true neoplasms and that adenomas are new growths within the breast. In this connection, it was first observed by Loeb,[1] then by us[2] and more recently by Heiman[3] that spontaneous adenomas from the breasts of white rats

From the William H. Singer Memorial Research Laboratory of the Allegheny General Hospital.

Read before Section N of the American Association for the Advancement of Science, Pittsburgh, Dec. 31, 1934.

1. Loeb, L.: Further Investigations in Transplantation of Tumors, J. M. Research **8**:44, 1902.

2. Robinson, George H., and Grauer, Robert C.: Transplantable Benign Adenomas in Rats, Am. J. Cancer **16**:184 (Jan.) 1932.

3. Heiman, Jacob: The Study of Benign Neoplasms of the Rat's Breast, Am. J. Cancer **22**:497 (Nov.) 1934.

could be transplanted almost indefinitely into succeeding generations. It is our purpose throughout the present article to show that all the changes that were observed in our experimental animals have been observed in human beings.

All the characteristics exhibited by the normal breast can be observed in adenomas of the breast. The normal breast undergoes definite cyclic changes in its appearance during the menstrual cycle very much as does the endometrium.[4] To parallel this observation, Ingleby [5] showed in her study of adenoma of the breast that the same or similar changes occur in the adenoma as occur in the breast proper during the menstrual cycle. We demonstrated, in 1932,[6] that the adenoma of the breast lactated simultaneously with the breast even when the tumor was transplanted at a subcutaneous site distant from all breast tissue. In order to further establish the fact that the lactation in the adenoma was independent of all connection with breast tissue we transplanted several bits taken from adenomas into the peritoneal cavities of several rats. Lactation occurred in the adenomas at the same time that it was established in the breasts of the rats after parturition. We further noted that involution in the adenomas and in the breasts occurred simultaneously after weaning. In some of the adenomas areas of abnormal involution and of cystic hyperplasia, called chronic cystic mastitis, occurred just as in some of the breasts. All of these changes have also been observed in adenomas of the human breast.

In our first communication regarding the transplantability of adenomas of the breast, we concluded, as did Loeb, that no "takes" were secured in male rats. We were mistaken in this conclusion, for growths in male rats were finally secured eighteen months after transplantation. The growths in the males developed more slowly, and the percentage of "takes" was less than in the females. Heiman secured 66 per cent "takes" in females and 33 per cent in males. The character of the growth was also different. In place of an even distribution of epithelial and connective tissue elements or even of a preponderance of glandular structures, we found a tendency toward an overgrowth of the fibrous tissue, with the resulting tendency toward the formation of a fibroma. This same change, which was originally observed in the male rats, became manifest in the female rats, but only after three years of successive transplantation. Finally a pure growth of fibrous tissue was obtained, in which all ducts and acini had been completely replaced

4. Rosenburg, quoted by Boyd, W.: Text-Book of Pathology, Philadelphia, Lea & Febiger, 1932, p. 651.

5. Ingleby, Helen: Relation of Fibro-Adenoma and Chronic Mastitis to Sexual Cycle Changes in the Breast, Arch. Path. **14**:21 (July) 1932.

6. Grauer, Robert C., and Robinson, George H.: Lactation in Transplantable Benign Mammary Adenomas in Rats, Am. J. Cancer **16**:191 (Jan.) 1932.

by the overgrowing connective tissue. Thus a pure fibroma was secured from the original adenofibroma. The counterpart of these experimental observations in the production of fibromas from fibro-adenomas was reported in the human subject by Halpert and Dial.[7] They cited the case of a woman 47 years of age who had a nodule removed from the breast three years previously (1927). In 1930 another nodule appeared in the same location, which on removal was observed to be a pericanalicular and intracanalicular adenoma in which there were practically no epithelial elements. Two years later the nodule recurred. A simple

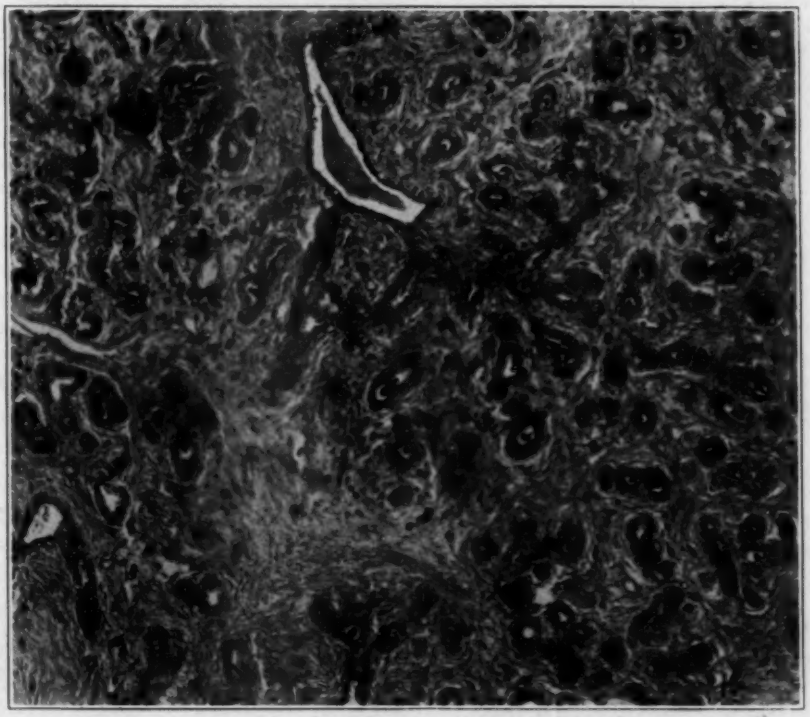

Fig. 1.—An area from a pericanalicular fibro-adenoma of the mammary gland of a rat.

mastectomy was performed, and a tumor 6 cm. in diameter was removed. This proved to be a pure fibroma. The authors concluded that the three tumors arising in this case—the first nodule, the nature of which was not known, the fibro-adenoma and finally the pure fibroma—probably bore no developmental relationship but were independent tumors that arose at different times in the same breast. Our observations on animals and the cases studied subsequently in human beings show that the fibrous

7. Halpert, Béla, and Dial, David L.: Fibroma of the Breast, Am. J. Path. **9**:905 (Nov.) 1933.

changes in original adenomas are an expression of altered growth rather than successive independent tumor formations.

One of the tumor nodules that had been transplanted for ten generations to successive female rats began to grow rapidly and caused ulceration of the overlying skin as a result of pressure. This tumor had been transplanted eight months previously from a slowly growing fibroma, which was derived from one of the original adenofibromas. This transplanted tumor measured approximately 8 cc. in diameter

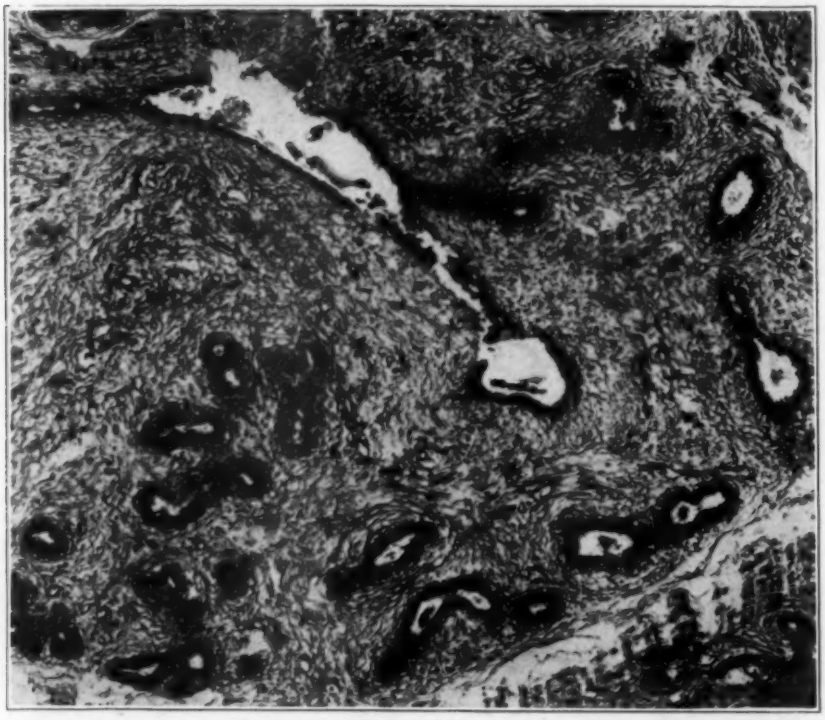

Fig. 2.—An area from a tumor nodule of a woman, showing similarity to the tumor of the rat (fig. 1).

and could be shelled away from the surrounding tissue quite easily. It was firm to the touch and was dull red and gray. When sectioned, it presented the typical appearance of the flesh of fish, which is so characteristic of sarcoma. Microscopically the tumor showed all the morphologic characteristics of a rapidly growing fibrosarcoma. It was extremely cellular and contained spindle-shaped cells, in many of which atypical mitotic figures were observed (fig. 6). There were no glandular structures in the tumor; the transformation from the original adenofibroma to a fibrosarcoma was morphologically complete. But, peculiarly, at this point the evidence of malignancy ceased. The tumor was not

invasive, being definitely circumscribed; it did not metastasize to any distant sites; it did not cause the death of the host. We were unable to find similar morphologic malignant changes in the fibromas of our male rats.

It is not essential that the tumors undergo an intermediary transformation to a fibroma in order to produce sarcomatous changes, though this is the common observation. We found one adenofibroma in which successive transplantation failed to cause a loss of the glandular structures but in which sarcomatous changes were observed. In this tumor

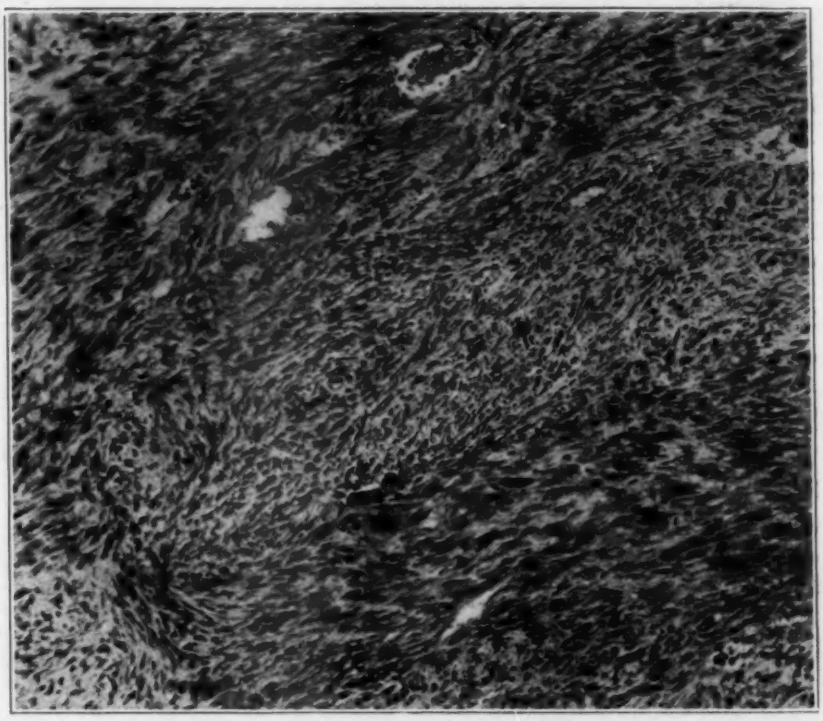

Fig. 3.—Replacement of the glandular structures and the sarcomatous change shown in a mammary tumor of a rat after transplantation for ten generations.

the overgrowing atypical fibroblasts showed progression in such a manner as to "sweep across the section" so to speak, replacing the preexisting adenomatous structures with highly proliferative and variously sized connective tissue cells (fig. 4). At this stage both adenoma and sarcoma existed simultaneously in the same section.

The tumor nodules that had undergone morphologic sarcomatous changes grew very rapidly after transplantation. Whereas it required from four to six months for a small adenomatous transplant that measured 0.5 cm. in diameter to reach a diameter of 6 cm., a transplant

of the sarcomatous nodule reached the same size in three or four weeks. While none of the tumors growing in male rats has advanced beyond the fibromatous stage up to the present time, transplants of sarcoma from the females to the males have grown with unabated rapidity and have shown the same microscopic pictures as those observed in the same tumors in the female rats.

In view of our experimental observations on sarcomatous changes in adenofibromas of the breast, the work of Sophian [8] is of extreme

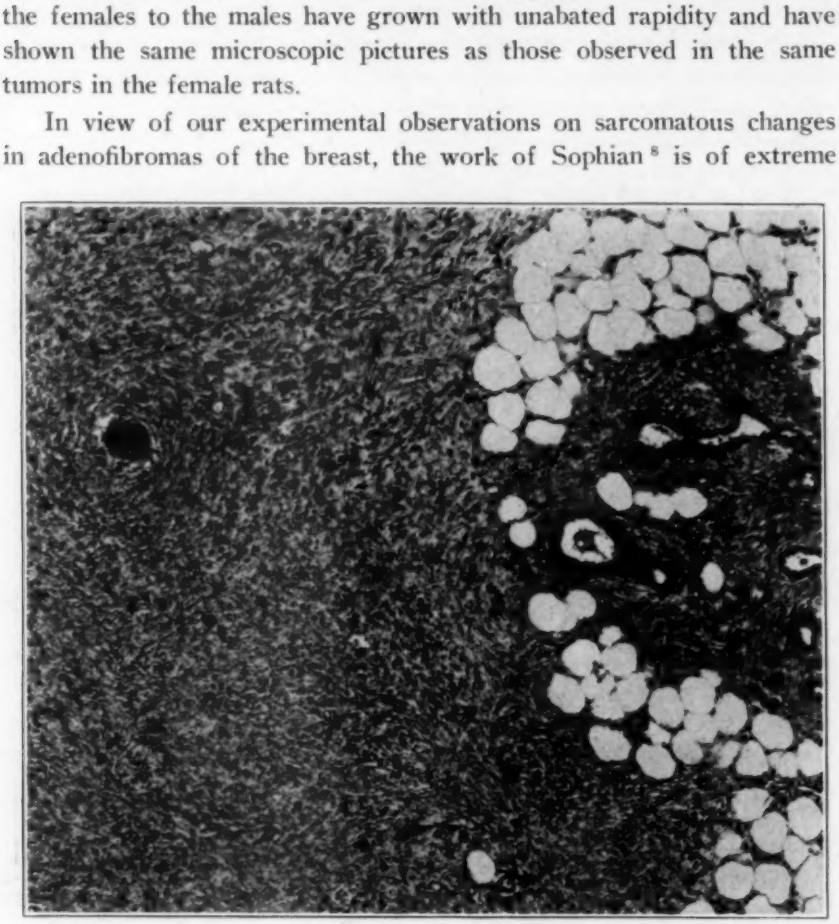

Fig. 4.—Sarcomatous change in a fibro-adenoma of a rat sweeping across the section and replacing the adenomatous structure.

interest. He studied the clinical histories and microscopic sections in fifteen cases of sarcoma of the breast and divided the tumors into two groups; the fibrosarcomas and the adenofibrosarcomas. The latter term was applied to those sarcomas in which epithelium-lined clefts still persisted but in which actively proliferating atypical fibroblasts abounded. He concluded that the adenofibrosarcoma probably arose from a preexisting adenofibroma and might develop into, or appear in recurrences

8. Sophian, L. H.: Adenofibrosarcoma of Breast, Arch. Path. **9**:1007 (May) 1930.

as, a pure fibrosarcoma. From six months to seven years after removal of the tumors five of the seven patients with adenofibrosarcoma were free from the disease. There were no metastatic nodules, and the lymph glands were not involved. He made a definite point of the fact that adenofibrosarcoma is a distinct type of sarcoma of the breast, and he accurately suggested its possible origin. All the points emphasized in Sophian's study of cases in human subjects were observed by us in our experimental studies.

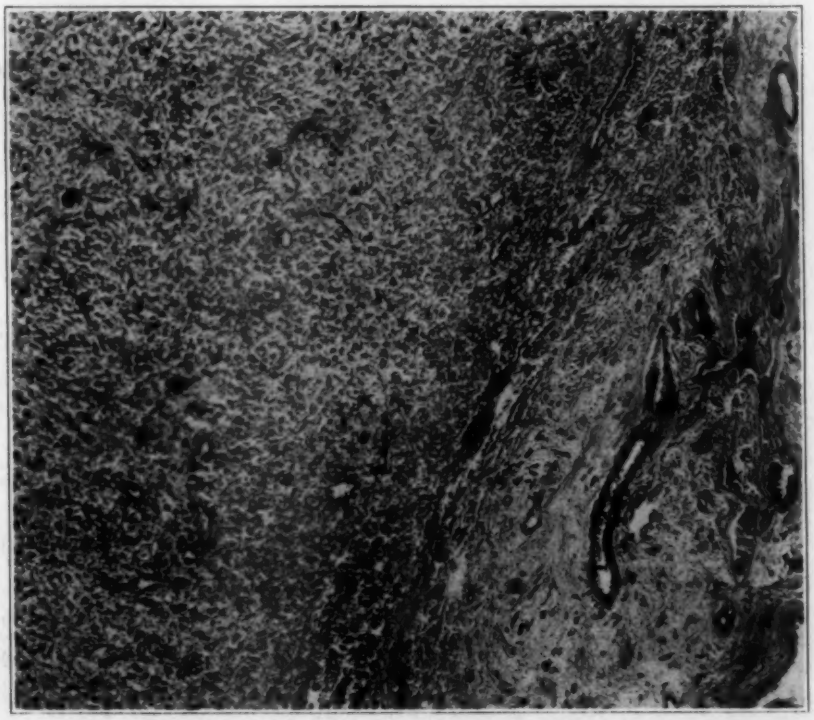

Fig. 5.—Section from a tumor of a human breast, showing change analogous to that seen in figure 4.

We were enabled to study sections of tumors from the breasts of two women and in both cases[9] the microscopic sections were indistinguishable from those of the tumors of our rats:

The first patient was a woman, aged 52 years, who had noticed a lump in the upper right quadrant of her breast only three weeks before consultation. The mass was the size of a walnut, was freely movable beneath the skin and was definitely circumscribed. There was no involvement of the regional axillary

9. Permission to study and report the following two cases was extended to us by Dr. Mortimer Cohen of the Magee Hospital and by Dr. J. P. Griffith and Dr. H. H. Permar of the Mercy Hospital.

glands. When removed it had the appearance of an adenofibroma. Microscopic sections revealed an intracanalicular fibro-adenoma of the breast, in which there were definite sarcomatous changes in the fibrous tissue. These sections were identical with those observed in the rat in which the glandular elements persisted, though sarcomatous change had occurred in the stroma. If no reference was made to the records, the two tumors could not be distinguished microscopically (figs. 4 and 5).

The second patient was a married woman aged 47. One year previously a small nodule was removed from her breast. This was not available to us for examination. Two months before her present admission to the hospital, the

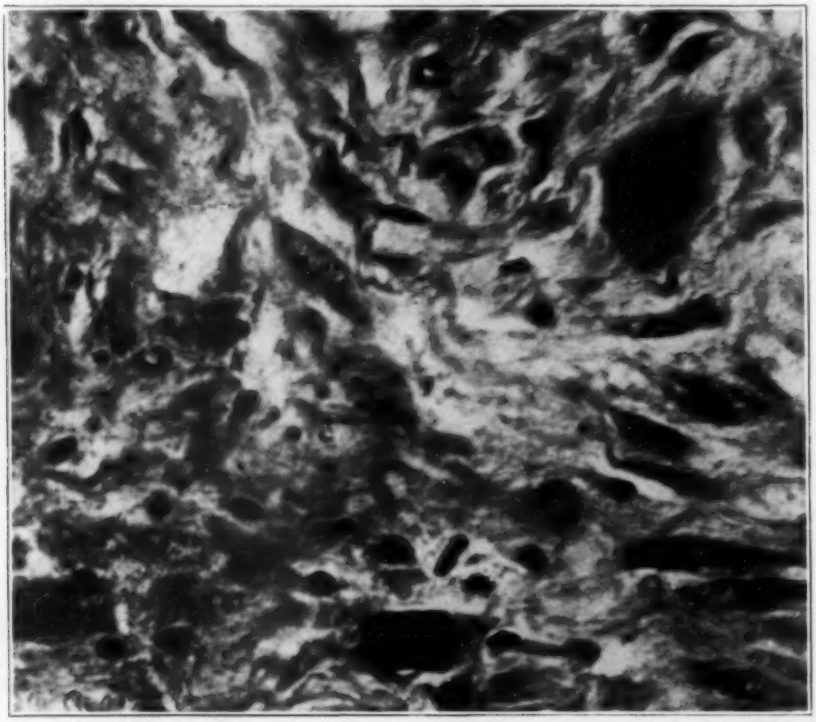

Fig. 6.—High power magnification of a fibro-adenosarcoma of a rat, revealing actively proliferating fibroblasts and numerous atypical mitotic figures.

patient observed that the breast from which the nodule had been removed began to enlarge and that it showed a daily increase in size. The breast at this time was tense, large and fluctuant. Eight hundred cubic centimeters of fluid was aspirated from it. Following this the breast filled again, and simultaneously with the catamenial flow bleeding began from the nipple. Examination of the axilla failed to show any glandular enlargement either on palpation or at operation. The breast was removed by simple mastectomy. The lower portion consisted of a large cyst that was filled with an edematous friable mass resembling coagulated serum and necrotic fat. The wall of the cyst was smooth but showed the presence of a few papillary projections. The microscopic picture in this case proved to be quite interesting. Whereas the transformation of the fibro-adenoma

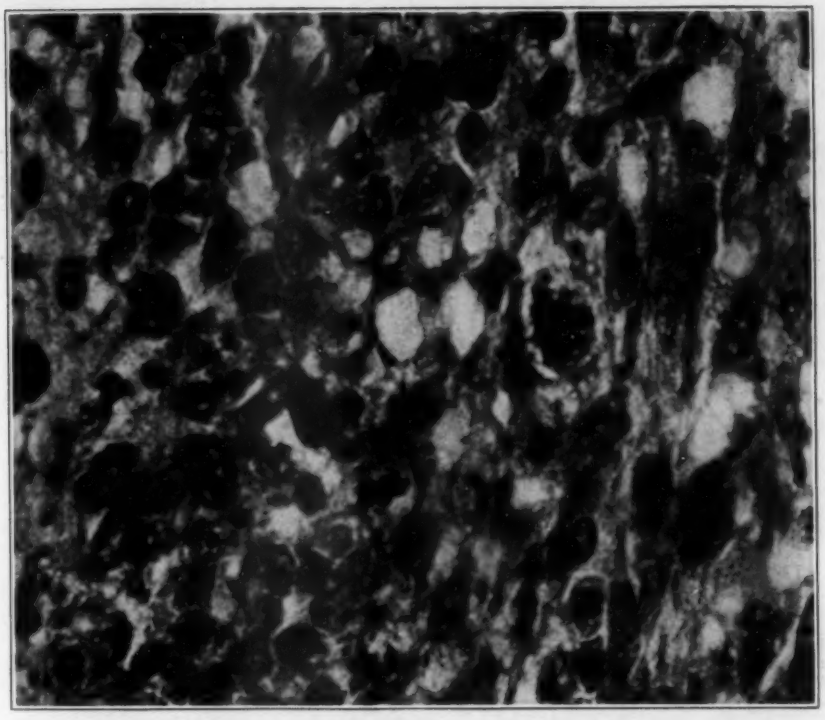

Fig. 7.—High power magnification from a fibro-adenosarcoma of a human breast, showing the same degree of activity as observed in the experimental tumor.

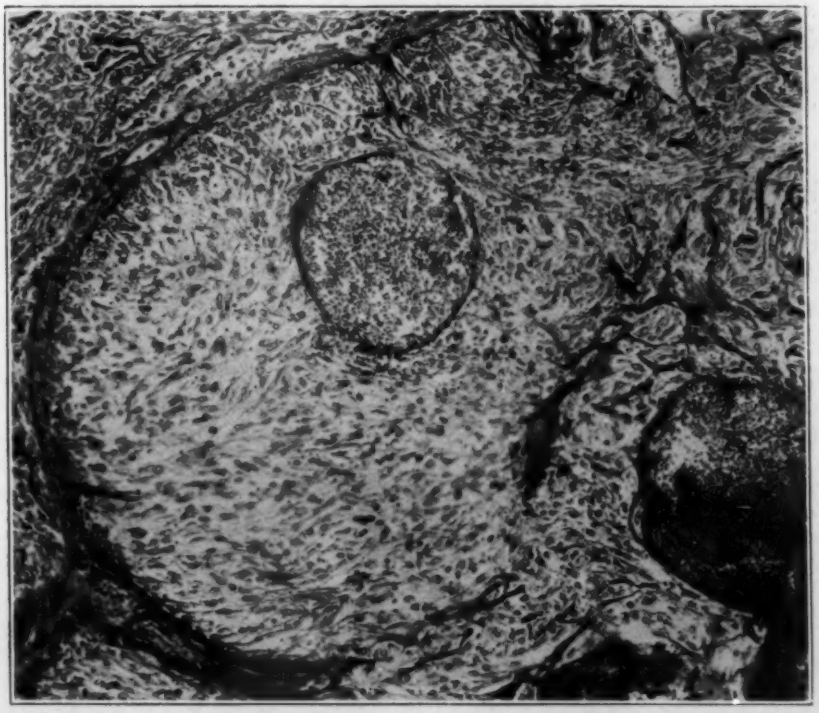

Fig. 8.—A fibro-adenosarcoma of the human breast (second case reported here). The maintenance of the architecture of an intracanalicular fibro-adenoma of the breast may be noted.

to sarcoma was only partially advanced in the first case, it was practically complete in the present instance. That this tumor arose from a preexisting intracanalicular fibro-adenoma could be adduced by a study of its architecture. Several areas of fibrous tissue showed the characteristic arrangement of an intracanalicular fibro-adenoma in which the compressed epithelial slits were still discernible (fig. 8). Other areas showed the persistence of the typical fibrous areas of the adenoma even though these showed early liquefaction necrosis. Those areas that had undergone sarcomatous changes still maintained, in places, the unique infolding and reduplication of the intracanalicular adenoma, with the exception that the fibrous stroma was highly proliferative and contained atypical mitotic figures in

Fig. 9.—Sarcomatous change in the stroma of the fibro-adenoma shown in figure 8.

abundance. The photomicrograph (fig. 8) shows this quite well. All other sections were characteristic of the ordinary rapidly growing fibrosarcoma.

The steady change of this tumor from a definitely benign state to a morphologically malignant one gives warning of its future possibilities. It serves as another link in the strong chain of evidence that all nodules of the breast, without exception, should be excised and investigated.

## COMMENT

The correlation of our experimental observations with the clinical findings establishes this tumor as a definite clinicopathologic entity and apparently explains the pathogenesis of this type of neoplasm of the

breast. The suggestion that this tumor be considered as adenofibrosarcoma is a logical one, for it is a generic as well as a descriptive term. Although the term sarcoma implies a highly malignant condition which is not observed in this particular tumor, one must necessarily employ it because of the fibrous nature of the tumor. This raises the point concerning the character of the fibrous tissue which is found immediately around the acini and from which it appears that this tumor arises. The periacinal fibrous tissue is of a looser texture and more embryonic in appearance. Owing to some unexplained factors it overgrows the epithelial elements and produces the alterations in the character of the tumor that were observed in the various transplants. It is interesting to speculate on the factors that may influence either connective tissue or epithelial overgrowth, but the known facts are too meager to permit one's arriving at a definite conclusion concerning tissue tension or determining the elements that keep epithelium from overgrowing fibrous tissue and vice versa.

The presence of hormones with tumor growths has been fairly well demonstrated in numerous instances. This has been especially noteworthy in the observations on hydatidiform mole, chorionepithelioma,[10] teratoma [11] of the testis and generalized carcinomatosis.[12] But it appears that with the advent of each new fact more questions arise that demand solution than previously existed. The newer interpretation of the production of various abnormalities of the breast as being an expression of hormonal activity appears logical to us, but we are reluctant to consider a definite neoplasm, such as a fibro-adenoma, as being merely an area of abnormal involution. We consider this especially true since we demonstrated that an adenofibroma of the breast will continue to grow indefinitely during transplantation whereas breast tissue when transplanted exhibits no neoplastic characteristics.

## CONCLUSIONS

Evidence is advanced to prove the existence of adenofibrosarcoma of the breast as a clinical and pathologic entity.

The mode of development of this tumor from a benign adenoma of the breast to a morphologic sarcoma is followed both in the experimental animal and in the human subject.

Emphasis is placed on the fact that true adenoma of the breast is a neoplasm and not an area of abnormal involution.

---

10. Ehrhardt, Karl: The Aschheim-Zondek Pregnancy Reaction, Surg., Gynec. & Obst. **53**:486 (Oct.) 1931.

11. Ferguson, R. S.: Quantitative Behavior of Prolan A in Teratoma Testis, Am. J. Cancer **18**:269 (June) 1933.

12. Jeffcoate, T. N. A.: The Occurrence of Pituitary Hormones in the Urine in Conditions Unassociated with Pregnancy, Lancet **1**:662 (March 26) 1932.

# FIBRO-ADENOMA OF THE BREAST DURING PREGNANCY AND LACTATION

CLARENCE S. MORAN, M.D.
OMAHA

Although little attention has been paid to fibro-adenomas of the breast observed during pregnancy and lactation, a study of these lesions is important since the changes seen are frequently confused with changes due to a malignant condition. Especially is such a study of interest in the light of the hormonal relationship of these lesions to the structure and function of the normal breast.

The term fibro-adenoma denotes an encapsulated fibro-epithelial lesion with either the pericanalicular or the intracanalicular type of connective tissue predominant.[1] Nineteen cases of fibro-adenoma modified by pregnancy, including 9 of lactating adenoma or so-called cystadenoma (Billroth, 1860; Gross, 1879; Power, 1885; Speese, 1909, and others), have been reported in the literature (McFarland, 1922, 1927; Sudler, 1923; Ingleby, 1932; Cheatle and Cutler, 1931, and others). Several cases reported before 1900 which might properly belong to this group were rejected because the variance in terminology and the lack of photomicrographs make it impossible to determine the true nature of the growths.

The 27 tumors (table 1) which form the basis for the present study were fibro-adenomas which were removed during pregnancy or lactation or following the cessation of lactation. These tumors were compared with 500 fibro-adenomas excised from menstruating women which were recently reported on by Oliver and Major (1934), the microscopic preparations of which I have since reviewed. A comparison of the two groups is shown in table 2. The pregnancy changes were compared with histologic sections made from human breasts during pregnancy and with numerous preparations from experimental animals, including mice, rats, guinea-pigs, rabbits and monkeys. These animals were pregnant or pseudopregnant or had had pregnancy changes induced by the administration of hormones.

Fibro-adenomas modified by pregnancy or lactation do not differ fundamentally in their clinical features from the tumors of the same type in nonparous females. They occur most frequently in subjects between the ages of 20 and 25, the age incidence ranging from 18 to 40 years. They are apparently most common in white women. At

---

Aided by a grant from the Anna Fuller Fund.

From the Surgical Pathological Laboratory, Department of Surgery, Johns Hopkins Hospital and University.

1. Pericanalicular lesions are known as fibromatous adenomas of the breast, and intracanalicular lesions as myxomatous adenomas of the breast.

TABLE 1.—*Data on Fibro-Adenomas Removed During Pregnancy and Lactation*

| Case | Race | Age, Years | Duration | Symptoms | Diameter, Cm. | Site[1] | Relation to Pregnancy and Lactation | Treatment | Type of Tumor | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | W | 32 | Years | Lump | 1.0 | UOQ | 1½ mo. preg. | Excision | Fibromatous | Well, 7 yr. |
| 2 | W | 20 | 3 mo. | Lump | 1.5 | UIQ | 2 mo. preg. | Excision | Fibromatous, Schimmelbusch | Well, 10 yr. |
| 3 | W | 20 | 3 wk. | Lump | ... | ..... | 3 mo. preg. | Excision | Fibromatous | Lost |
| 4 | W | 24 | 2 mo. | Lump, pain | 3.0 | UOQ | 3 mo. preg. | Excision | Myxomatous | Well, 3 yr. |
| 5 | W | 23 | 2 mo. | Lump, pain | 1.0 | LOQ | 3 mo. preg. | Excision | Fibromatous | Lost |
| 6 | W | 28 | 18 mo. | Lump, pain | 2.5 | ..... | 3 mo. preg. | Excision | Myxomatous | Well, 4 yr. |
| 7 | W | 26 | 6 mo. | Lump | 3.0 | ..... | 4 mo. preg. | Excision | Myxomatous | Lost |
| 8 | W | 19 | 6 mo. | Lump | 3.0 | UIQ | 4 mo. preg. | Excision | Myxomatous | Well, 6 yr. |
| 9 | W | .. | ..... | Lump | 2.5 | ..... | 6+ mo. preg. | Excision | Fibromatous | Well, 11 yr. |
| 10 | W | 31 | 3 mo. | Lump | 3.0 | UIQ | 7 mo. preg. | Excision | Fibromatous | Well, 1 yr. |
| 11 | W | .. | ..... | Lump | ... | ..... | 6 wk. lact. | Excision | Fibromatous | Lost |
| 12 | W | 23 | 15 mo. | Lump, pain | 5.0 | LOQ | 3 mo. lact. | Excision | Fibromatous | Lost |
| 13 | W | 30 | ..... | Lump | 1.0 | ..... | 5 mo. lact. | Excision | Myxomatous | Lost |
| 14 | W | 34 | 14 mo. | Lump | 15 | ..... | 10 mo. lact. | Amputation | Myxomatous | Well, 8 yr. |
| 15 | W | 34 | 10 mo. | Lump, pain | 2.0 | UOQ | 10 mo. lact. | Excision | Fibromatous | Well, 25 yr. |
| 16 | W | 22 | ..... | Lump | 1.5 | UOQ | End of lact. | Excision | Myxomatous | Lost |
| 17 | W | 29 | 30 mo. | Lump | 2.5 | UIQ | End of lact. | Excision | Fibromatous | Well, 11 yr. |
| 18 | W | 30 | 1 mo. | Lump | ... | ..... | 5 mo. involut. | Excision | Myxomatous | Well, 4 yr. |
| 19 | W | 40 | ..... | Lump | 1.5 | UOQ | 6 mo. involut. | Excision | Myxomatous | Lost |
| 20 | W | 31 | 6 yr. | Lump | 2.5 | LIQ | 8 mo. involut. | Excision | Fibromatous | Lost |
| 21 | W | 19 | 5 yr. | Lump | 3.0 | UOQ | 12 mo. involut. | Excision | Myxomatous | Lost |
| 22 | W | 28 | 15 mo. | Lump, pain | 1.5 | LIQ | 15 mo. involut. | Excision | Myxomatous | Lost |
| 23 | W | 28 | 3½ yr. | Lump | 3.0 | UOQ | 2 yr. involut. | Excision | Myxomatous | Well, 2 yr. |
| 24 | W | 37 | 14 yr. | Lump | 1.0 | UIQ | 2 yr. involut. | Excision | Myxomatous | Well, 10 yr. |
| 25 | W | 41 | ..... | Lump | ... | UOQ | 8 yr. | Excision | Cystic disease | Well, 2 yr. |
| 26 | W | 41 | ..... | Lump | 2.0 | UOQ | 8 yr. | Excision | Cystic disease | Lost |
| 27 | W | 35 | 9 yr. | Lump | 3.0 | ..... | ..... | Excision | Fibromatous | Well, 5 yr.; died |

1. UOQ indicates upper outer quadrant; UIQ, upper inner quadrant; LOQ, lower outer quadrant; LIQ, lower inner quadrant.

TABLE 2.—*Comparison of Fibro-Adenomas Removed During Pregnancy and Lactation with Fibro-Adenomas in General* *

| | General Fibro-Adenomas | Fibro-Adenomas During Pregnancy and Lactation |
|---|---|---|
| Number of cases | 500 | 27 |
| Age at onset | 20 to 25 yr. | 20 to 25 yr. |
| Race | White | White |
| Duration | | |
| Fibromatous | 44 mo. | 34 mo. |
| Myxomatous | 31 mo. | 34 mo. |
| Symptoms | | |
| Lump | 83% | 100% |
| Pain | 35% | 22% |
| Location | Upper and outer quadrant most frequent | Upper and outer quadrant most frequent |
| Mobility | 56% | 100% |
| Multiple | 15% | 7% |
| Surrounding breast, lumpy | 5% | 7% |
| Clinically benign | 94% | 97% |
| Treatment | Excision | Excision |

1. Summary of 500 cases analyzed by Oliver and Major.

the time of examination the tumors in this series had had an average known duration of thirty-four months. The chief complaint was the presence of a definitely enlarging lump in the breast (27 cases); pain and tenderness were noted in 6 cases and discharge from the nipple in 1 case. One patient (case 12) complained of rapid enlargement of the mass accompanied by pain and tenderness after the onset of lactation. Trauma was recorded in the history in 2 cases.

The physical findings in cases of fibro-adenoma in pregnant or lactating women are also essentially the same as those in the nonparous group. The lesion is located most frequently in the upper and outer quadrant from the midzone to the periphery of the breast and occurs with about equal frequency in the two breasts. The diameter varies from 1 to 16 cm., the average being from 2 to 3 cm.; but size apparently has no relationship to the age of the tumor. The consistency ranges from soft or rubbery to firm. In the group studied all but 1 patient showed a single palpable lump; all the growths were freely movable. There was no retraction of the nipple, dimpling of the skin, atrophy of the subcutaneous fat or enlargement of the axillary glands. In only 1 case (case 14) was there discoloration of the skin and distention of the superficial veins. This tumor was 16 cm. in diameter and occupied the entire breast. All the tumors, therefore, were clinically benign except the last one mentioned, concerning which there was doubt. Although the results of transillumination were not recorded, it is probable that the tumors that were larger than a 25 cent piece would have cast a shadow.

All the tumors were observed to be encapsulated when examined grossly. They varied in shape from round to oval and were smooth in contour. The consistency varied with the degree and amount of pregnancy hypertrophy, the tumor being spongy when the hypertrophy was extensive. One tumor which on palpation was considered to be a single nodule proved to be multiple. Of the tumors that were removed before parturition, 5 showed macroscopic pregnancy changes. On section they were observed to be granular. In the 3 growths in which pregnancy hypertrophy was not seen grossly the nature of the fibrous stroma could be distinguished, being pericanalicular in 1 and intracanalicular in 2. In 2 cases sections only were received. Seventeen tumors were removed during or after lactation. Lactation changes were noted macroscopically, and milk was expressed from 6. Six of the remaining 11 tumors were classified as intracanalicular fibro-adenomas. In 5 cases sections only were received.

### PREGNANCY CHANGES

Fibro-adenomas are histologically modified by pregnancy and lactation. During pregnancy the microscopic changes correspond in general to those seen in the surrounding normal breast, the chief difference being

in the amount and regularity of the parenchymatous hyperplasia. Epithelial proliferation may be extensive enough to obscure the identity of the tumor, or it may be almost or completely absent. Usually the distribution of the change is very irregular, and large areas of tumor may be apparently unmodified by the pregnancy hyperplasia (fig. 1). Unless the tumor is hyalinized and of long standing, some degree of change is always seen. Multiple tumors in the same breast may show varying

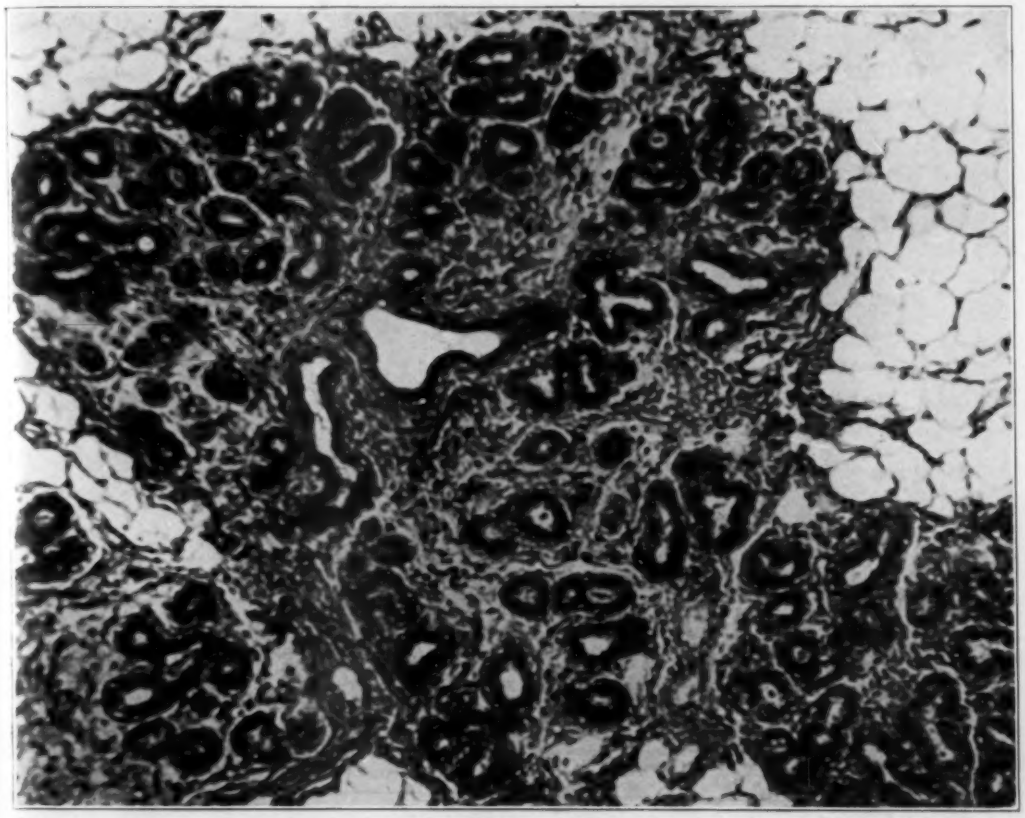

Fig. 1 (case 4).—Photomicrograph showing early and irregular proliferation in the fat of an intracanalicular fibro-adenoma which was removed during the third month of pregnancy. The tumor had been present for two months and was painful and increasing in size.

degrees of response. Although this variability was not observed in any of the tumors of the present series, it was well illustrated by a case reported by McFarland in which the patient had 3 fibro-adenomas in the same breast. The largest tumor showed nearly complete pregnancy hypertrophy, and a smaller tumor showed some change, but practically no hypertrophy was observed in the smallest nodule.

Rosenburg (1922), Ingleby (1932) and others have shown that the normal cyclic changes seen in the breast during menstruation occur also in the fibro-adenomas. In the premenstrual phase the terminal ducts are dilated and epithelium proliferates at the tips. The periductal connective tissue is cellular, pale and edematous.

The premenstrual changes are continued in the first third of the period of pregnancy. The small bulbous sprouts consisting of solid cords of epithelium at the ends of the system of ducts invade the surrounding connective tissue, which is decreasing in amount. These sprouts contain deeply stained cells with vesicular nuclei and numerous mitotic figures. The invading mass is surrounded sometimes by an indistinct basement membrane. As the strands of cells become canalized, the process is repeated; thus the intralobular ducts arise, acini are added and new lobulettes (lobule) are formed. As the epithelial changes occur, the amount of periductal and intralobular connective tissue gradually diminishes, suggesting a reciprocal relationship between the parenchyma and its supporting tissue. The fat which is closely associated with the lobule disappears.

Maturing lobulettes and proliferating cords of epithelium may be seen in a single microscopic field in the first third of the period of pregnancy. The infiltrating epithelium with its numerous mitotic figures is frequently mistaken for cancer. Such a picture is shown in figure 2. The rate of proliferation however gradually declines, and by the fifth or sixth month (figs. 3 and 4) no proliferative activity can be seen and the lobulettes approach maturity. At that time the acini are rounded, and the acinar cells vary in shape from cuboidal to columnar, with their nuclei located near the bases. Also, secretory globules, sometimes seen in the more advanced lobulettes as early as the second and third months, begin to appear in the acinar cells. Small amounts of secretion collect in the acini as well as in the ducts, making the intralobular ducts difficult to distinguish from the acini unless examined in serial section. The larger ducts, which are irregular in contour and lined with deeply staining cuboidal or columnar epithelium, may also contain a small amount of secretion. The lining cells, however, show no secretory globules.

During the second half of pregnancy, secretory activity becomes more marked and the blood supply gradually increases. The acini and ducts increase in size and become distended with a secretion containing albumin, various-sized fat globules and so-called colostrum bodies. The secreting cells enlarge and stain less intensely. Their nuclei are compressed toward the basement membrane by the secretory globules, which coalesce in the central end of the cells and cause them to bulge into the lumens of the acini, thus producing lumens of various shapes. As the lobulettes increase in size, the connective tissue continues to disappear until before labor the stroma is reduced to thin strands between the

lobulettes and the acini. Since these pregnancy changes are usually irregularly distributed, areas of unaffected tissue may be seen.

Scattered throughout the tumor and near the large ducts are seen rudimentary or refractory lobulettes corresponding to the preménstrual lobulettes seen in all stages of pregnancy and lactation. For some reason these structures have failed to respond to the stimuli of pregnancy. Their presence and number seem roughly in inverse proportion to the number

Fig. 2 (case 5).—Photomicrograph showing early pregnancy change in a fibro-adenoma which might be mistaken for cancer. The patient was white and aged 23. The tumor was removed during the second month of pregnancy. It had been discovered about two months previously. Although the new structures are infiltrating, the cells are of similar size and stain uniformly. An intact basement membrane can be distinguished.

of lactations and are apparently less frequent or even absent in the breasts of multiparous women. Lewis and Geschickter (1934) have suggested that these structures have some relationship to chronic cystic mastitis.

Ten tumors were removed during pregnancy; 6 were pericanalicular and 4 intracanalicular. Pregnancy hypertrophy was noted in 9 cases, in 8 of which there was a history of growth. However, in the remaining case (case 8) there was pregnancy hypertrophy, and the tumor had

Fig. 3 (case 9).—Photomicrograph showing pregnancy hypertrophy in a pericanalicular fibro-adenoma removed in the sixth month of pregnancy. The distribution of the pregnancy hypertrophy in the tumor is irregular.

therefore probably grown. The pregnancy changes were diffusely distributed in 5 cases and irregularly distributed in 4. In the tenth case (case 1), in which there was no evidence of pregnancy hyperplasia, the tumor had been present for a number of years, and its size had remained

stationary during the previous pregnancy. It was pericanalicular and partially hyalinized.

In each of 2 cases (cases 8 and 10) 2 tumors were found, the sister tumors being identical microscopically.

### LACTATION CHANGES

During lactation, as in pregnancy, the microscopic picture corresponds with that of the surrounding breast. The ducts and acini are

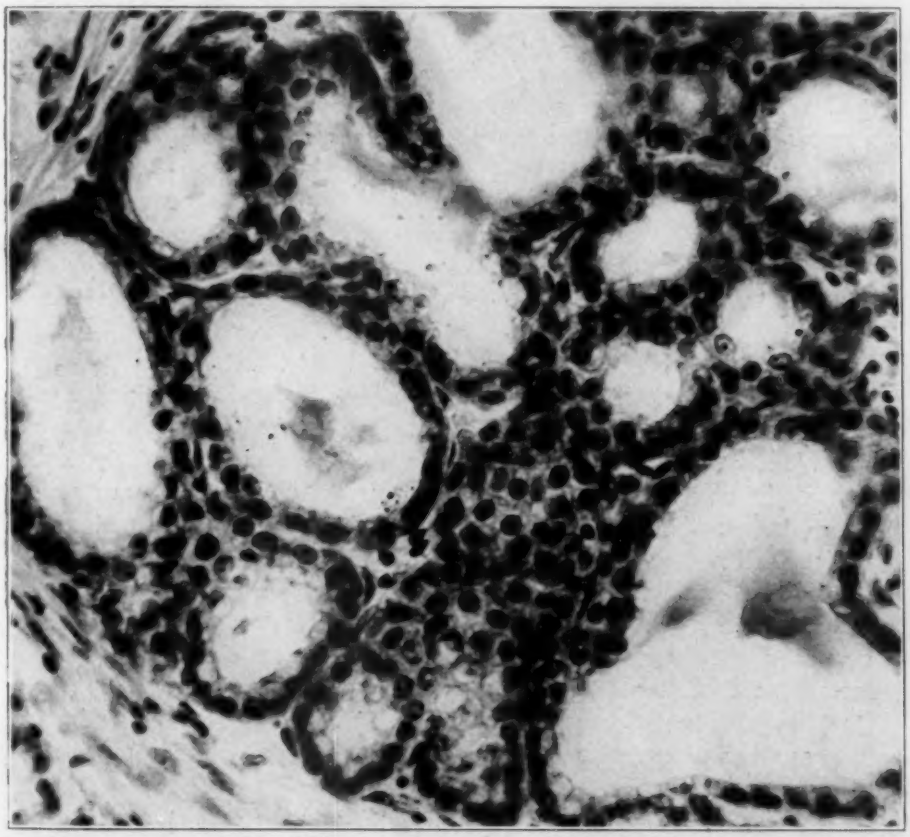

Fig. 4 (case 9).—Photomicrograph showing an area in which the lobulettes are forming, the acini are dilating and secretory activity is beginning.

dilated and filled with secretion. No colostrum bodies are seen. The cells lining the acini are columnar or cuboidal; they stain poorly and are filled with globules of secretion. The lumens are irregular. The intralobular connective tissue is reduced to a minimum. Although numerous lobulettes may be seen secreting, others in the same field are frequently observed in a resting stage, with cells of uniform size and con-

taining very few globules of secretion. Their acinar lumens are narrow and collapsed.

Occasionally during, or more especially near, the onset of lactation a tumor which has enlarged but slightly during pregnancy or has even been unnoticed may enlarge rapidly. If the mass does not diminish in size during nursing, the drainage system has been either cut off or blocked. One such case (case 12) is included in this series. The patient had two children, 18 months and 3 months of age, respectively. The tumor had been noticed for fifteen months. It increased in size but slightly during pregnancy. During the third month of lactation it suddenly enlarged from the size of a walnut to that of a lemon, became tender and painful and required surgical intervention. Microscopically the acini and ducts were markedly distended with secretion. No involution was noted.

Seven tumors (4 pericanalicular and 3 intracanalicular) were removed during or at the end of lactation. On section milk could be expressed from 6. Only 4 had a history of growth, but lactation hypertrophy was noted in all. Some showed beginning involution. The distribution of the change was regular in 3 and irregular in 4.

Involution proceeds as in the normal breast. The acini become smaller, the lining cells atrophy, the amount of secretion diminishes, and finally the lobulettes collapse. Here again the histologic picture may superficially suggest cancer. These changes also occur irregularly, and frequently lactating as well as involuting areas may be seen in a single field (fig. 5). The glandular areas are invaded by phagocytes, and cells loaded with fat (specially stained) can be seen in the various lymphatic channels. Accompanying the parenchymatous changes, the periductal and periacinar connective tissue again proliferates. Gradually the glandular structures are destroyed, the connective tissue is in part restored, and the tumor may resume its nonpregnant state or disappear completely. These changes may be completed in a few months following cessation of lactation but sometimes are delayed for from two to fifteen months (fig. 6).

Occasionally areas of so-called residual lactation persist for years. In one case of the series (case 26, figure 7) a diagnosis of cystadenoma with residual lactation hypertrophy was made. The patient, a white woman aged 41, after nursing her child eight years previously had noted an intermittent milky discharge from the left nipple. About one and one-half years prior to admission she discovered a small lump in the left breast. Physical examination revealed that the ducts beneath the nipple were dilated, and there was a tumor about 2 cm. in diameter in the upper and outer quadrant. Both breasts felt shotty. The mass was excised and macroscopically was identified as a fibro-adenoma. Microscopically the encapsulated tumor showed areas of pericanalicular and

intracanalicular fibro-adenoma, cystic areas and areas which looked like lactation hypertrophy. These areas however were identical with the lobular changes in the adenocystic (Schimmelbusch) type of chronic cystic mastitis. No secretory globules were seen in the cells. The cystic areas were also identical with the small cystic areas seen in cystic disease of the breast.

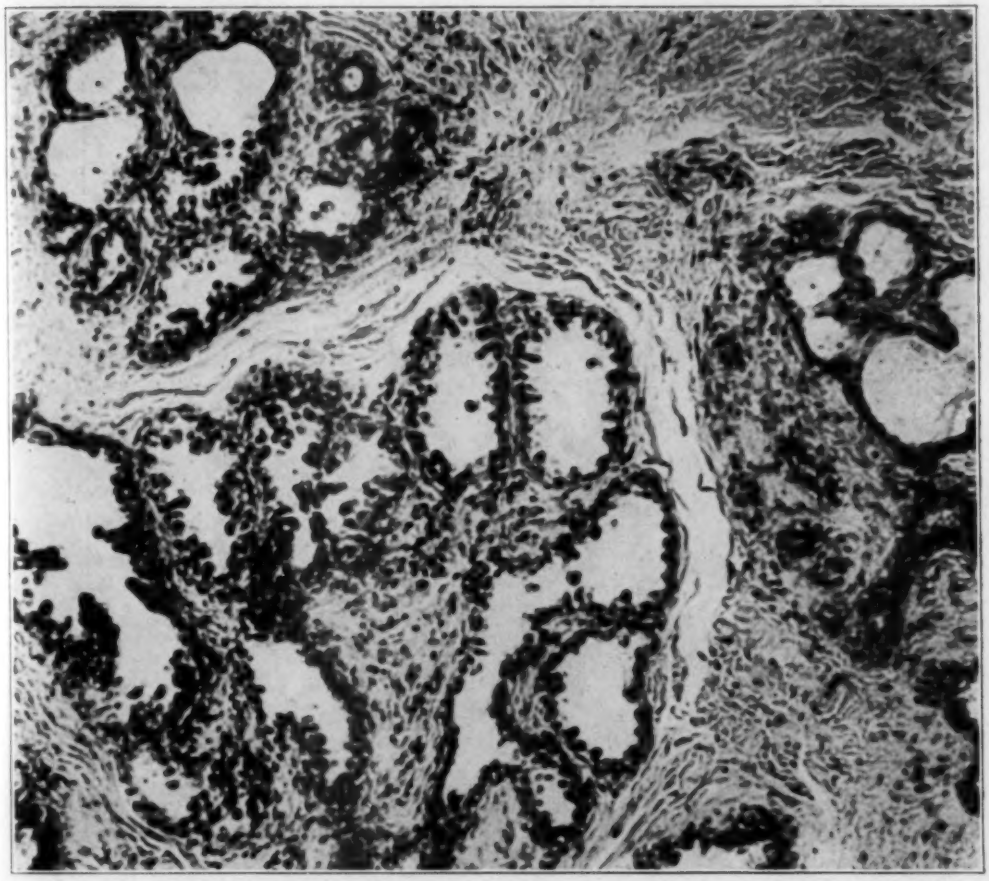

Fig. 5 (case 17).—Photomicrograph showing lactation and involution in a single field of a fibro-adenoma. This tumor, which had been present for thirty months, was excised two months after the infant was weaned. A few dilated acini can be seen. Secretory activity had almost ceased. Involution is marked. The surrounding normal breast presents the same type of change.

In my opinion the changes seen in this tumor, the cystic areas and the so-called residual lactation hypertrophy were probably the result of chronic cystic mastitis. The indefinite history of onset, the intermittent discharge, the dilated ducts beneath the nipple and the presence of chronic cystic mastitis in both breasts support this opinion. No doubt

chronic cystic mastitis is frequently mistaken for cystic fibro-adenoma and residual lactation hypertrophy, and the latter diagnosis should not be accepted until the Schimmelbusch type of chronic cystic mastitis is ruled out. The microscopic picture in cystic disease complicating a fibro-adenoma is shown in figure 8. Lewis and Geschickter have recently shown that chronic cystic mastitis is associated with hormonal disturbances, and since fibro-adenomas respond to the hormones controlling the development and function of the breast, it is reasonable to suppose

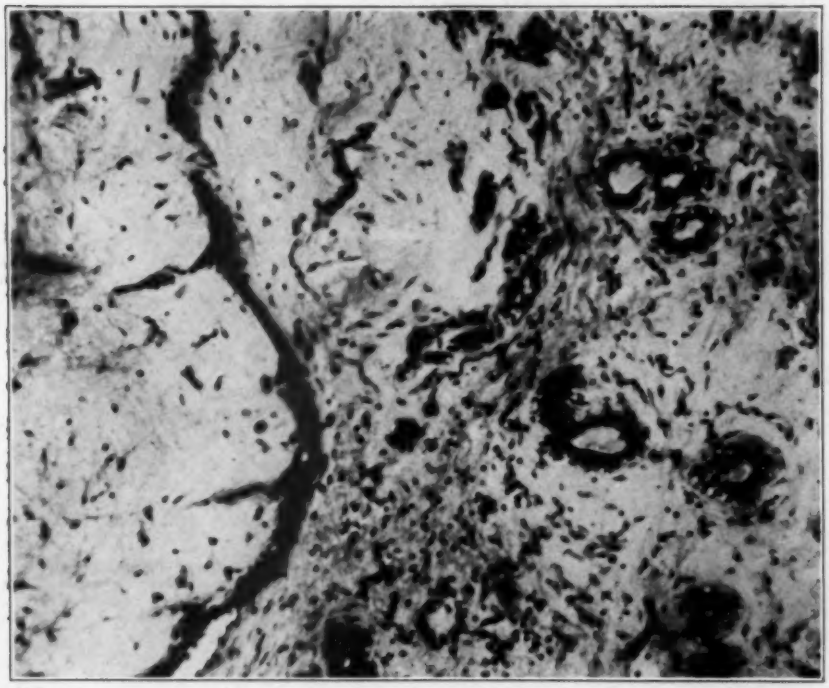

Fig. 6 (case 19).—Photomicrograph of a tumor discovered at the end of lactation. The patient nursed her child for three months. The tumor was removed eleven months later. A few intact acini can be seen, but the section is predominately one of involution. The collapsed and atrophic acini are disappearing. Phagocytic activity is marked.

that these lesions also may be involved in the hormonal imbalance responsible for chronic cystic mastitis.

Of the 10 tumors removed after lactation had ceased, 5 were intracanalicular, 2 were pericanalicular and 3 were mixtures of both types. Only 3 had a history of growth during pregnancy.. Five showed areas of residual hypertrophy with involution. Two (cases 25 and 26) were interpreted as chronic cystic mastitis complicating fibro-adenoma. No changes were detected in 3. Three tumors had been present during more than one pregnancy. One (case 20) had been present for six

years, and evidence of involution was noted when it was removed eight months following parturition. The tumors in cases 24 and 27 had been present for nine and fourteen years, respectively. In neither was lacta-

Fig. 7 (case 26).—Photomicrograph of so-called residual lactation hypertrophy in a cystadenoma. This tumor was removed eight years after lactation. The patient complained of an intermittent milky discharge and a lump in the breast. The section shows an area of lobular proliferation without secretory activity adjacent to numerous cystic areas.

tion hypertrophy or involution evident, although in the former there was a history of growth during the last pregnancy. Five small tumors

ranging from 0.5 to 1 cm. in diameter were discovered either late in lactation or after lactation had ceased. In each case evidence of lactation hypertrophy could be seen microscopically, indicating that the tumors had been present or had originated during pregnancy but were not discovered until beginning involution.

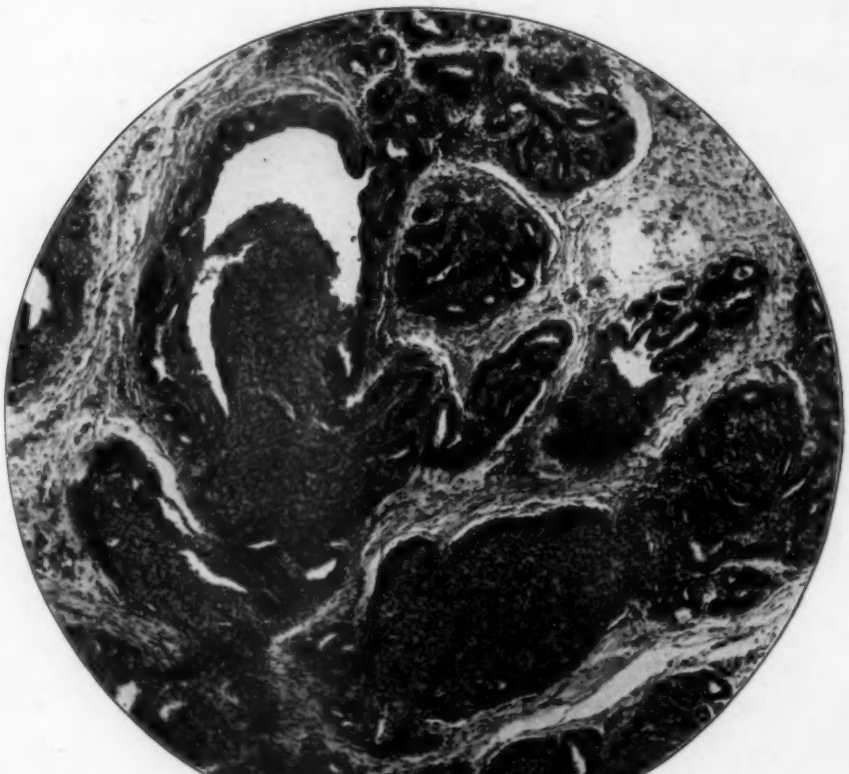

Fig. 8 (case 2).—Photomicrograph showing chronic cystic mastitis of the Schimmelbusch type in a fibro-adenoma which is beginning to undergo pregnancy hypertrophy. The tumor was removed during the second month of pregnancy.

## COMMENT

The changes seen in fibro-adenomas during pregnancy and lactation are identical and occur simultaneously with the physiologic changes in the surrounding breast at these periods. Also these changes can be simulated if not actually reproduced in the mammary glands of animals by the administration of the appropriate hormones. It has been clearly demonstrated that the growth and development of the mammary glands in animals are dependent on the estrogenic principle and the progestational

hormone from the corpus luteum. The estrogenic principle controls the growth and development of the nipples and the system of ducts and also sensitizes the ducts to the action of the hormone from the corpus luteum, which is responsible for the development of the lobules (Allen, 1932; Corner, 1929, 1930; Turner, 1931, 1933, and others). The administration of the lactogenic principle from the anterior lobe of the pituitary body to an animal with a mammary gland prepared with the estrogenic principle or with the estrogenic principle and the hormone from the corpus luteum results in the secretion of milk (Stricker and Grüeter, 1929; Corner, 1930; Riddle, 1933; Gardner and Turner, 1935, and others).

Clinically there has long been recognized a relationship between the human breast and the ovary, as demonstrated by the effects of castration and the menopause; by the normal development of the breast at puberty in girls and the rudimentary state of development in boys; by the abnormal mammary development in cases of ovarian tumor in children; by the presence of lobules in the breast only after functional activity of the corpus luteum, and by the cyclic changes which occur in the breast at each menstrual cycle.

The mammary changes produced during pregnancy and lactation are induced by hormones known to be present in high concentration at these times. Aschheim and Zondek (1928) and the Smiths (1934) have shown that the estrogenic principle is present in the blood in gradually increasing amounts during pregnancy in human beings. This is thought to be of placental origin (Allen, 1932). Though there is at present no practical method of detecting the progestational hormone from the corpus luteum in the blood stream, such a hormone is known to be present, and its effects are demonstrated both in the breast and in the uterus. It is thought to be functionally active at least in the early part of pregnancy, and degenerative changes in this endocrine body are usually not seen before the fifth or sixth month of pregnancy. Opinion, however, is divided as to the duration of function of the corpus luteum. It has been shown by Ask-Upmark (1926), Pratt (1927) and Waldstein (1929) that the corpus luteum can be removed early in pregnancy without causing abortion. This phenomenon indicates that the hormone from the corpus luteum is not long required for the maintenance of pregnancy, but it does not prove that this hormone is nonessential for complete mammary development. It is also possible that the secretion of this hormone is taken over, as in the case of estrogenic principle, by another organ, namely, the placenta. The hormone from the corpus luteum has recently been demonstrated to be present in the placenta at full term by Adler, De Fremery and Tausk (1934), but as yet it has not been determined whether it is secreted or only stored there.

The milk-stimulating hormone of the anterior lobe of the pituitary body has been shown to be necessary for the secretion of milk in animals. It is also effective in hypophysectomized animals (Riddle, 1933; Collip and his associates, 1933). Although there is little experimental evidence to show the effect of such a hormone in human beings, it is evident that the pituitary body is in some way involved in the process of lactation. This is indicated by certain cases of pituitary tumor in which lactation has been known to last for extended periods (Cushing, 1932). Recent experiments by Kurzrok, Bates, Riddle and Miller (1934) indicate that administration of this hormone of the pituitary gland may be of value in increasing the supply of milk in women with an insufficient amount. While a hormone of the pituitary gland is probably responsible for lactation in human beings as in laboratory animals, there is as yet no definite proof either of its presence or of its necessity in human beings.

Microscopically, mammary development in human beings and that in animals are essentially the same, both depending on the ovary. It has been proved that this control is hormonal in animals. The hormones known to be necessary for the development of mammary glands of animals are present in high concentration in human beings during pregnancy. The "ovarian hormones" have been shown, at least in some instances, to have the same effect in human beings as in animals. This has been demonstrated by replacement-therapy and by the experimental production of menstrual periods (Werner and Collier, 1933; and Loeser, 1934) and of hyperplastic endometrium (Schroeder, 1915; Novak, 1924, 1933; Fluhmann, 1931, and others), although little is known of the actual mechanism of the action of these hormones or of the part played by other endocrine glands.

By inference from animal experimentation it may be suggested, therefore, that during the early stage of pregnancy fibro-adenomas of the breast show epithelial proliferation in response to the progestational hormone from the corpus luteum. In later pregnancy an increasing concentration of the estrogenic principle probably produces changes in the fibrous elements. During lactation, distention and secretory activity in the acini are stimulated by a pituitary principle. After removal of these relatively intense hormonal stimuli, involutional changes develop.

## DIAGNOSIS AND TREATMENT

When a lesion of the breast is presented for diagnosis during pregnancy or lactation, the important question is that of malignancy. Knowledge of the patient's age and the condition revealed by transillumination of the tumor may be of value; but since the majority of lesions seen at that time are single and clinically benign, a biopsy is necessary to establish a diagnosis.

Cancer of the breast arising during pregnancy and lactation is not rare. Kilgore (1923, 1929) estimated that 4.5 per cent of all cancers in persons below the age of 47 occur in the breast during that period. Ninety per cent occur in persons over 30. However, cancer arising in a fibro-adenoma is rare. In a series of 500 cases analyzed by Oliver and Major (1934) and in 250 cases studied by Semb, no cancer was reported. None was observed in this small series. Nevertheless, changes occurring in a fibro-adenoma during pregnancy and lactation are frequently confused with cancer (15 in this series). This difficulty is encountered most frequently during the first three months of pregnancy (fig. 2) and during late involution. In the early stage of pregnancy, though the proliferating structures are infiltrative and mitotic figures are numerous, the process is orderly and produces a definite pattern, the cells are similar in size and stain uniformly, and the new ducts and acini are usually surrounded by a basement membrane. In the late stages of involution the collapse of the lobules and ducts produces a more or less formless mass of cells. Close examination reveals an intact basement membrane, absence of mitosis and invasion, fatty degeneration of the epithelium and marked invasion of the gland by phagocytes.

While the ultimate decision rests on microscopic sections, the diagnosis can usually be made macroscopically. Cancer is never encapsulated but is usually circumscribed. It is firm to the touch, and when sections are cut there is noted the grittiness of an unripe pear. The cut surface is concave and white, with yellow streaks and areas of necrosis. From a comedo or duct cancer wormlike masses can be expressed. In fibro-adenoma the consistency varies from firm to soft. Section reveals that the tumor is encapsulated, and the cut surface usually corresponds more or less closely to the surrounding breast. If the normal proliferative and involutionary changes characteristic of this physiologic period are borne in mind, there should be little difficulty in distinguishing fibro-adenoma from cancer.

If an encapsulated tumor is larger than one quadrant of the breast, Bloodgood (1917-1929) recommended that it be regarded as a sarcoma and treated as such. Sarcoma of the breast, however, is not a common lesion. Fox (1934) noted only 60 sarcomas in a series of about 3,500 lesions of the breast. Of this number 22 arose in fibro-adenomas, being more frequent in the intracanalicular type. They occurred usually in fibro-adenomas of long standing, with the average age of onset between 45 to 50. Stout (1932), Semb (1930), McFarland (1926, 1927) and others have reported cases in which a sarcoma arose in a fibro-adenoma, and the report of 1 possible case of sarcoma is included here.

### REPORT OF A CASE

CASE 14.—Mrs. M. M., aged 34, when five months pregnant, noted a lump in the left breast about the size of a 5 cent piece. The mass increased in size

until the onset of lactation and then ceased to grow. The breast lactated normally for nine months. When the patient was seen (Sept. 20, 1927), ten months after delivery, the tumor was 16 cm. in diameter and occupied practically all the breast. The superficial vessels were dilated, resembling varicose veins. There was no edema or pigskin, nor was the nipple retracted. The tumor was not adherent to the chest wall. Milk could be expressed from the nipple following manipulation of the tumor. The surrounding breast was lumpy. The axillary nodes were not palpable. Operation was performed on September 27.

As the appearance of the frozen section suggested a diagnosis of sarcoma, the breast and the underlying pectoral muscles were removed. The tumor was observed to be encapsulated, and on section milk could be expressed. The macroscopic impression was sarcoma or intracanalicular fibro-adenoma with lactation hypertrophy. Microscopically (fig. 9) the tumor was an intracanalicular fibro-adenoma that was partially hyalinized, with areas of lactation hypertrophy undergoing involution. The fibrous tissue response was extreme, and many mitotic figures were observed. Young connective tissue cells which did not invade the stroma or destroy the lobular structures surrounded the ducts and acini concentrically. The cells were concentrated next to the basement membrane of the ducts and acini, gradually diminishing in number as the distance from the parenchymatous structures increased to blend imperceptibly with the supporting framework.

This picture suggested a sarcoma confined within an encapsulated tumor, but the absence of any history of growth during lactation, the absence of invasion and destruction, the uniform arrangement of the connective tissue, the hyalinization of much of the tumor and the lack of metastasis were against a diagnosis of sarcoma. The fact that the patient is living and well eight years after operation is additional proof that the tumor was probably benign. This, however, is not infallible, because 13 (60 per cent) of the 22 patients with sarcoma arising in fibro-adenoma reported on by Fox were living and well from three to nineteen years after mastectomy, the average duration being eight years. Therefore, though this might be a case of a cured malignant sarcoma, the bulk of evidence points to its benignancy.

The differential diagnosis of sarcomas not arising in fibro-adenomas should offer no difficulty. The tumor may be of two types, fascial or neurogenic. Grossly, such lesions are not encapsulated, and the cut surface is homogeneous, soft and fleshy, with none of the necrotic areas or striations of cancer. Microscopically, whether fascial or neurogenic in type, they are composed of elongated spindle cells, with numerous mitotic figures and occasional tumor giant cells. The tumor rapidly invades and destroys the surrounding breast tissue.

Lactation mastitis, galactocele, fat necrosis and tuberculosis also must be considered in making a diagnosis. Lactation mastitis usually occurs during the first three months of lactation. The lump is hot, tender and painful, and the overlying skin may be reddened. If resolution or abscess formation does not take place in two weeks, the mass should be explored. Microscopically the picture is one of inflammatory

change with destruction of the lobular structures. Galactoceles are commonly seen during lactation and usually follow lactation mastitis. Grossly, cystic spaces filled with milk are noted. Histologically they are observed to be composed of a fibrous wall infiltrated with inflammatory cells.

In fat necrosis a history of trauma is usually obtained. On section the lesion is observed to be circumscribed and usually small. It may be

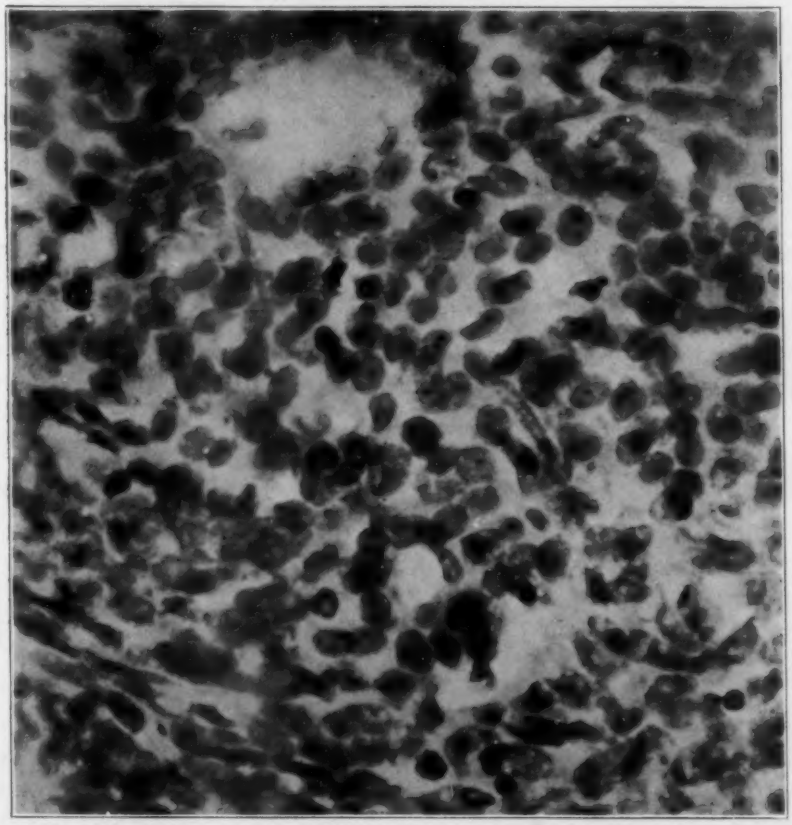

Fig. 9 (case 14).—Photomicrograph of a possible sarcoma arising in a lactating adenoma. The tumor had been present for fourteen months. It grew rapidly during pregnancy and failed to grow during lactation. The patient is living and well eight years after the operation.

cystic, with an oily or fatty content. There may be patchy areas of calcification. Microscopically the diagnosis is based on the amount of destruction of breast tissue and on the presence of calcified material, cholesterol crystals, giant cells and occasionally blood pigment. Evidence of tuberculosis, though uncommon, is usually found in patients with pulmonary tuberculosis. The presence of a sinus is pathognomonic of the

condition. Microscopically the typical picture includes caseation, giant cells, epithelial cells, lymphocytes and a fibrous tissue reaction.

Any lump in the breast noted during pregnancy or lactation should be explored immediately unless the patient is under 25 or unless the lesion resembles lactation mastitis. In the case of mastitis, two weeks may be allowed for involution or abscess formation. Since the diagnosis cannot usually be definitely established without making a frozen section, the patient should be prepared for a complete operation when removal of tissue for biopsy is undertaken. If the patient is lactating the breast should be emptied before exploration. After the tumor is exposed the presence of a capsule should be determined and a section taken. The wound should then be cauterized with 50 per cent zinc chloride, after the method of Bloodgood (1917, 1929). If the lump is benign, it should be excised with a margin of normal breast tissue. If the tumor is larger than one quadrant of the breast and is of the spindle cell type, it should be treated as a sarcoma, and the breast should be removed. After a biopsy the nursing of the infant is permitted.

It is preferable to remove these tumors during pregnancy, when the breast is less vascular and when there is less secretory activity than during lactation. If a lump which grows rapidly during pregnancy is left in the breast it may enlarge sufficiently to produce symptoms requiring surgical intervention when circumstances are such that complete removal of the breast may be necessary, whereas local excision earlier in pregnancy would have saved the breast. Lactation also increases the changes of postoperative complications, hematoma and mastitis. However, in the cases considered here no such complications occurred.

Nine of the patients in this series are living and well five years after operation, 6 are living and well after less than five years. Twelve patients have not been heard from lately but were living and well when last heard from. One patient died after five years, the cause of death being unknown. No interference with subsequent lactations or pregnancies was recorded.

## SUMMARY

A report is made on 27 fibro-adenomas removed during pregnancy and lactation or present during that period and removed at varying intervals following the cessation of lactation. It was observed that the tumors were modified by pregnancy and lactation and that the changes produced in them were similar to those occurring simultaneously in the surrounding normal breast. The endocrine factors involved in the development and function of the breast are chiefly discussed, and it is suggested that the changes observed both in the breast and in the fibro-adenoma are of hormonal origin.

## BIBLIOGRAPHY


Adler, A. A.; de Fremery, P., and Tausk, M.: Progestin in Placental Extract, Nature, London **133**:293, 1934.

Allen, E.: The Ovarian Follicular Hormone, Theelin; Animal Reactions, in Allen, E.: Sex and Internal Secretions, Baltimore, Williams & Wilkins Company, 1932, p. 392.

Bloodgood, J. C.: The Breast, in Binnie, J. F.: A Treatise on Regional Surgery, Philadelphia, P. Blakiston's Son & Co., 1917.

Benign Tumors of the Breast; Encapsulated Adenoma, Ann. Surg. **79**:172, 1924.

The Treatment of Tumors of the Breast During Pregnancy and Lactation, Arch. Surg. **18**:2079 (May) 1929.

Boothe, A. E.: Simple Lactating Adenoma of the Breast, Am. J. M. Sc. **170**: 731, 1925.

Burch, J. C.; Williams, W. L., and Cunningham, R. S.: The Etiology of Endometrial Hyperplasia, Surg., Gynec. & Obst. **53**:338, 1931.

Cheatle, G. L., and Cutler, M.: Tumors of the Breast, Philadelphia, J. B. Lippincott Company, 1931.

Cohn, L. Clarence: Chronic Lactation Mastitis, Suppurative and Nonsuppurative, Am. J. Cancer **3**:461, 1932.

Collip, J. B.; Selye, H., and Thomson, D. L.: Further Observations on the Effect of Hypophysectomy on Lactation, Proc. Soc. Exper. Biol. & Med. **30**:913, 1933.

Corner, G. W.: The Hormonal Control of Lactation, Am. J. Physiol. **95**:43, 1930.

Cushing, H.: Basophil Adenomas of the Pituitary Body and Their Clinical Manifestations (Pituitary Basophilism), Bull. Johns Hopkins Hosp. **50**:137, 1932.

Deaver, J., and McFarland, J. J.: The Breast, Philadelphia, P. Blakiston's Son & Co., 1926.

Ewing, J.: Neoplastic Diseases, ed. 3, Philadelphia, W. B. Saunders Company, 1931.

Fellner, O. O.: Zur Theorie der Milchsekretion, Klin. Wchnschr. **10**:1167, 1931.

Fluhmann, C. F.: Hyperplasia of the Endometrium and the Hormones of the Anterior Hypophysis and the Ovaries, Surg., Gynec. & Obst. **52**:1051, 1931.

Fox, S. L.: Sarcoma of the Breast, with a Report of Sixty Cases, Ann. Surg. **100**:401, 1934.

Frank, R. T.: The Female Sex Hormone, Springfield, Ill., Charles C. Thomas, Publisher, 1929.

Gardner, W. U., and Turner, C. W.: The Function, Assay and Preparation of Galactin, a Lactation Stimulating Hormone of the Anterior Pituitary and an Investigation of the Factors Responsible for the Control of Normal Lactation, Missouri Agric. Exper. Stat. Research Bull. 196, 1933.

Greenough, R. B., and Simons, C. C.: Fibro-Epithelial Tumors of the Mammary Gland, Ann. Surg. **54**:517, 1911.

Gross, S. W.: True Adenoma of Mamma, Am. J. M. Sc. **78**:459, 1879.

Horsley, J. S.: Benign Tumors of the Breast, South. M. J. **13**:356, 1920.

Ingleby, H.: Relation of Fibro-Adenoma and Chronic Mastitis to Sexual Cycle Changes in Breast, Arch. Path. **14**:21 (July) 1932.

Influence of Sex Cycle on Breast Lesions, Lancet **2**:835, 1932.

Kilgore, A. R.: Tumors of the Breast Arising During Pregnancy and Lactation, California State J. Med. **21**:15, 1923.

Tumors and Tumor-Like Lesions of the Breast in Association with Pregnancy and Lactation, Arch. Surg. **18**:2086 (May) 1929.

Kreibig, W.: Ueber das Schwangerschaftsadenom der weiblichen Brustdrüse, Wien. klin. Wchnschr. **43**:972, 1930.

Kurzrok, R.; Bates, R. W.; Riddle, O., and Miller, E. G., Jr.: The Clinical Use of Prolactin, Endocrinology **18**:18, 1934.

Lewis, D., and Geschickter, C. F.: Ovarian Hormones in Relation to Chronic Cystic Mastitis, Am. J. Surg. **24**:280, 1934.

Loeser, A.: Artificial Production of Menstruation with Ovarian Hormones in Cases of Primary and Secondary Amenorrhea, J. Obst. & Gynec. Brit. Emp. **41**:86, 1934.

McFarland, J.: Residual Lactation Acini in the Female Breast: Their Relation to Chronic Mastitis and Malignant Disease, Arch. Surg. **5**:1 (July) 1922. Adenofibroma and Fibroadenoma of the Female Breast, Surg., Gynec. & Obst. **45**:729, 1927.

Mazer, C., and Goldstein, L.: Clinical Endocrinology of the Female, Philadelphia, W. B. Saunders Company, 1932.

Novak, E., and Martzloff, K. H.: Hyperplasia of the Endometrium, Am. J. Obst. & Gynec. **8**:835, 1924.

Oliver, R. L., and Major, R. C.: Cyclomastopathy: Physio-Pathological Conception of Some Benign Breast Tumors, Am. J. Cancer **21**:1, 1934.

Power, D'Arcy: True Adenoma of the Breast, Tr. Path. Soc. London **36**:411, 1885.

Pratt, J. P.: Corpus Luteum in Its Relation to Menstruation and Pregnancy, Endocrinology **11**:195, 1927.

Riddle, O.; Bates, R. W., and Dykshorn, S. W.: The Preparation, Identification and Assay of Prolactin, a Hormone of the Anterior Pituitary, Am. J. Physiol. **105**:191, 1933.

Rosenburg, A.: Ueber menstruelle, durch das Corpus luteum bedingte, Mammaveränderungen, Frankfurt. Ztschr. f. Path. **27**:466, 1922.

von Schultz, A.: Pathologische Anatomie der Brustdrüse, in Henke, F., and Lubarsch, O.: Handbuch der speciellen pathologischen Anatomie und Histologie, Berlin, Julius Springer, 1933, vol. 7, pt. 2, p. 1.

Selye, H.; Collip, J. B., and Thomson, D. L.: Nervous and Hormonal Factors in Lactation, Endocrinology **18**:237, 1934.

Semb, C.: Fibroadenomatosis Cystica Mammae, Acta chir. Scandinav. **66**:457, 1930.

Smith, G. V., and Smith, O. W.: Excessive Gonad-Stimulating Hormone and Subnormal Amounts of Oestrin in Toxemias of Late Pregnancy, Am. J. Physiol. **107**:128, 1934.

Speese, J.: Pure Adenoma of the Breast, Proc. Path. Soc. Philadelphia **12**:291, 1909.

Sudler, M. T.: Lactating Intracanalicular Lipomyxofibro-Adenoma of the Breast, S. Clin. North America **3**:1599, 1923.

Turner, C. W.: The Mammary Glands, in Allen, E.: Sex and Internal Secretions, Baltimore, Williams & Wilkins Company, 1932, p. 544.

Werner, A. A., and Collier, W. D.: The Effect of Theelin Injections on Castrated Women, J. A. M. A. **100**:633 (March 4) 1933.

# "OSTEOID-OSTEOMA"

## A BENIGN OSTEOBLASTIC TUMOR COMPOSED OF OSTEOID AND ATYPICAL BONE

HENRY L. JAFFE, M.D.
Pathologist, Hospital for Joint Diseases
NEW YORK

The present article is a report on five cases of a type of benign neoplasm of bone apparently not hitherto classified. All the cases came to my attention during 1933.[1] They had the following features in common: 1. The patients were all adolescents or young adults from 11 to 22 years old. 2. In each case the principal complaint was of local pain, usually increasing and often severe enough to interfere with sleep. It was this symptom that brought the patients to consult a physician. 3. Uniformly, the lesion originated in an area of spongy bone. Although it sometimes involved cortical bone, it never penetrated the periosteum. 4. As observed roentgenographically, the pathologic areas were roundish, clearly circumscribed and confined within the bone. 5. The lesions were small and closely similar in size: Two were about 0.5 cm., two were 1 cm., and one was 2 cm., in diameter. 6. In every case operation was performed on the assumption that the condition was inflammatory—osteomyelitis or an abscess of the bone—but pus was not found in any instance. 7. Complete eradication resulted in the eventual disappearance of all symptoms without recurrence of the local condition.

CASE 1.—*History.*—The patient was a man 22 years old who first came for treatment to the outpatient department on June 14, 1933. Two years before admission to the hospital his left ankle began to be tender anteriorly. Stiffness in the region and limping developed, apparently in consequence of the pain. The pain gradually became worse and was believed to have been aggravated by some stretching treatments given by an osteopath about three months before the patient was seen at the clinic. The pain now radiated down the ankle anteriorly. The limp which was developing remained constant. The patient remembered that about four years before he slipped and injured the ankle. A hematoma formed anterior to the external malleolus. However, this resolved within a few days, and no symptoms referable to the ankle appeared until two years later. Neither at the time of admission nor previously was there difficulty in connection with any other joint region.

*Examination.*—Clinical examination revealed that a large area of the dorsal surface of the left foot (over the head of the astragalus and extending in front of the malleoli) was tensely swollen. There was no redness or local heat, however.

1. Since this manuscript was submitted I have encountered three additional instances of the condition to be described. These cases coincide very closely, in regard to both clinical and pathologic manifestations, with the five cases to be discussed in the present article.

Forced dorsiflexion was somewhat restricted and painful, and there was marked tenderness on deep pressure on either side of the tibialis anticus tendon. The rest of the clinical examination and the clinical laboratory tests yielded nothing worthy of note.

A roentgenogram taken on June 16 revealed the presence of a circular abnormality in the superior portion of the neck of the astragalus (fig. 1). The pathologic area lay directly in front of the trochlea and measured roughly 1 cm. in diameter. As the roentgenogram demonstrated, the lesion created a bulge in the contour of the superior surface of the neck of the bone. It was apparent roentgenographically that near the periphery of the globuloid lesion there was an annular zone that was demarcated from the rest of the lesion by its lesser permeability to light. The hollow in the astragalus was likewise delimited by such a zone.

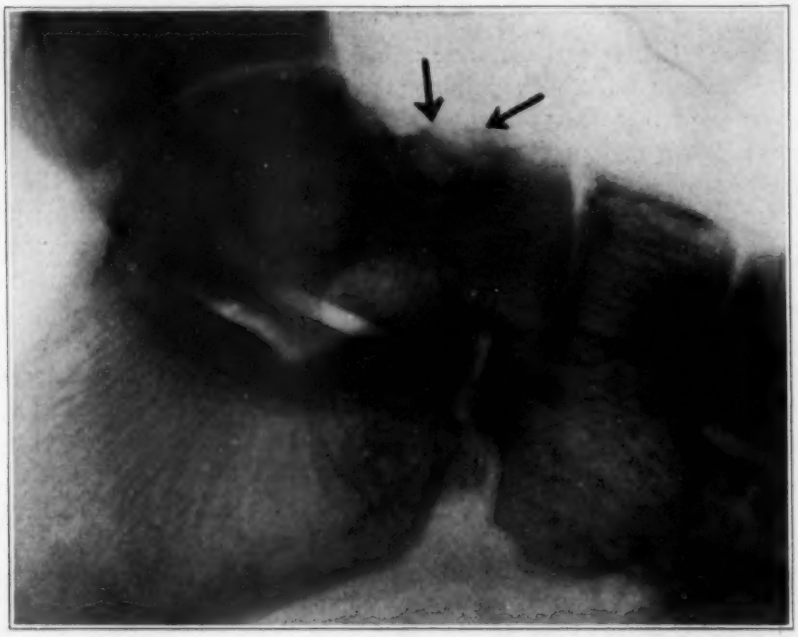

Fig. 1 (case 1).—Roentgenogram showing the circular lesion with its central core in the superior portion of the neck of the astragalus. The lesion was about 1 cm. in diameter.

Intermediary between the darker zones was a lighter one. The core of the lesion was also relatively highly permeable to light.

*Operation.*—An operation was done on June 29 on the assumption that the lesion in the astragalus was a sequestrum associated with osteomyelitis. At this time Dr. Sashin found the tissues overlying the upper surface of the astragalus very edematous and much thickened, while the neck of the bone was somewhat bulged out. A shell of surface was lifted with an osteotome. Underneath the shell a lump of bone was found which was easily lifted out. It corresponded in size and shape to the abnormal shadow observed in the roentgenogram.

*Bacteriologic Study.*—Culture of the material removed at operation revealed a diphtheroid bacillus. A guinea-pig inoculated with some of the material died

eighteen days later. At its autopsy considerable postmortem changes were found, but there was no evidence of tuberculosis either grossly or microscopically.

*Course.*—The postoperative course was satisfactory. Within four months after the operation the wound had completely healed and the patient was able to bear full weight on the foot. A control roentgenogram taken ten months after the operation revealed that the defect in the astragalus created by removal of the lesion had been filled in. The healing had proceeded to almost total replacement of the previously diseased area by healthy tissue.

Fig. 2 (case 1).—Photomicrograph (magnification, × 10) of the lesion shown in figure 1. Note the core of newly formed trabeculae with cellular intertrabecular marrow (*a*), the peripheral zone of calcified osteoid (*b*), and the intermediary zone of uncalcified osteoid (*c*).

*Pathologic Observations.*—The so-called sequestrum from the left ankle was seen on gross inspection to be a mass of rather soft bony tissue. Serial paraffin sections revealed no trace of original bone. The tissue was composed essentially of (1) osteoid, large areas of which, especially in the periphery, were calcified, and (2) a network of very thin, newly formed, more or less centrally placed trabeculae between which there was (3) a loose, highly vascular fiber marrow (fig. 2).

The histogenesis of the lesion could be read microscopically. It was apparent that the formation of osteoid through the agency of osteoblasts constituted an important feature of the pathologic process. What was even more significant was the calcification of the osteoid, observed especially around the periphery of the lesion. The abundant formation of osteoid was not, of course, unaccompanied by osteoclasis, however. Everywhere in the sections, reconstruction, especially through resorption of the calcified osteoid, was in progress. Numerous osteoclasts were to be observed where the reconstruction was most active. It was near the sites of destruction and removal of the denser and calcified osteoid that the formation of new osteoid through the deposition of intercellular material between osteoblasts was most lively (fig. 3).

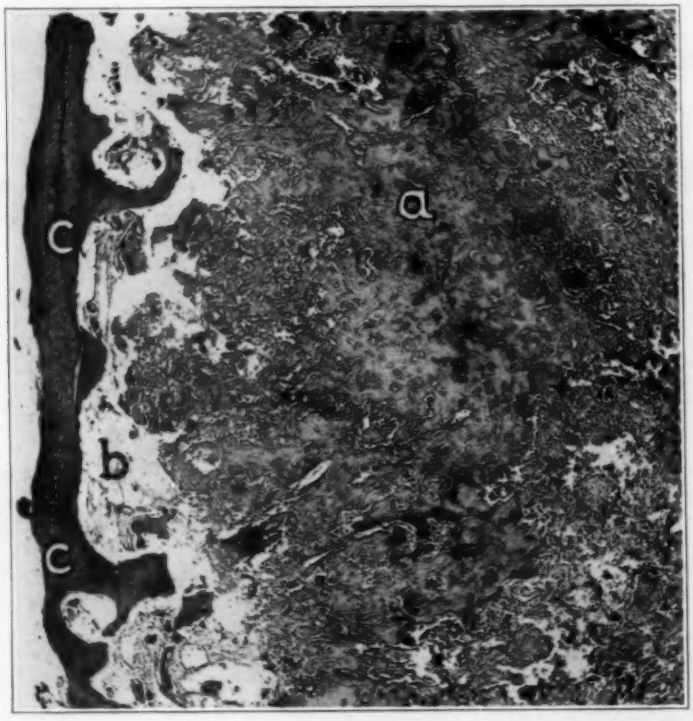


Fig. 3 (case 1).—Photomicrograph (magnification, × 50) showing histologic details at the periphery of the lesion. Note the calcifying osteoid (*a*), and the zone between the tumor (*b*) and the perifocal original bone (*c*).

As already noted, the more central portion of the lesion was occupied by a network of delicate trabeculae. These were covered by osteoblasts which seemed to be actively depositing new bone. Many of these trabeculae were indented by Howship's lacunae containing osteoclasts. Between these trabeculae was a loosely fibered, highly vascular osteogenic mesenchymal connective tissue.

Several additional fragments of bone were studied which had been curetted from the part of the astragalus cupping the total globuloid neoplastic mass of osteoid and new bone. These showed that the original bone trabeculae in these fragments had been thickened somewhat by the deposition of new lamellar bone.

Their architecture had also been somewhat modified by resorption. Between these thickened trabeculae of lamellar bone was a fatty fiber marrow. The globuloid neoplastic mass of osteoid and new bone was clearly differentiated but was not bound off from the sclerotic perifocal spongy bone by any special capsule or border.

*Interpretation of the Roentgen Findings.*—In the light of the pathologic observations one can see why the core of the lesion was relatively highly permeable to the roentgen rays (fig. 2). This core consisted of a delicate reticulum of poorly calcified new bone and osteoid. The relative darkness of the annular zone within the periphery of the lesion was due to the fact that the tissue in that zone consisted of densely compacted calcified osteoid. The hollow in the astragalus cast a denser shadow because it was composed of spongy trabeculae which had become some-

Fig. 4. (case 2).—Roentgenogram showing the dense, homogeneous, circular shadow in the sulcus of the calcaneus.

what sclerotic. The intermediate shadow of relatively high permeability to light was found to be due to the presence of osteoid that had not calcified.

CASE 2.[2]—*History.*—The patient was a girl 11 years old who was admitted to the University Hospitals, Iowa City, on April 21, 1933.

In the previous August the patient twisted her right foot. In spite of this she was able to play and walk, but two weeks later her ankle began to be painful. Toward the end of December 1932 the pain became worse, especially at night.

*Examination.*—Clinical examination revealed a swollen ankle which was very tender, especially on the inner side. Motion was markedly painful, and there was muscle spasm. The muscles of the thigh and calf showed atrophy. The clinical laboratory tests yielded negative results.

2. The data on this case were made available by Dr. Ernst Freund of the Department of Orthopedic Surgery, State University of Iowa, College of Medicine.

The roentgenogram, a print of which was also submitted by Dr. Freund, disclosed a lesion in the upper anterior portion of the calcaneus in the region of the sulcus (fig. 4) which showed as a dark (i. e., relatively less light-permeable) disk about 6 mm. in diameter, surrounded by a narrow, faint, lighter ring. Much other bone of the calcaneus in the vicinity of this circular lesion was also less permeable to light than more remote portions of the bone, apparently because of perilesional osteosclerosis.

*Operation and Course.*—Exploration of the subastragaloid region was performed on May 1. The specimen to be described later was removed at this time.

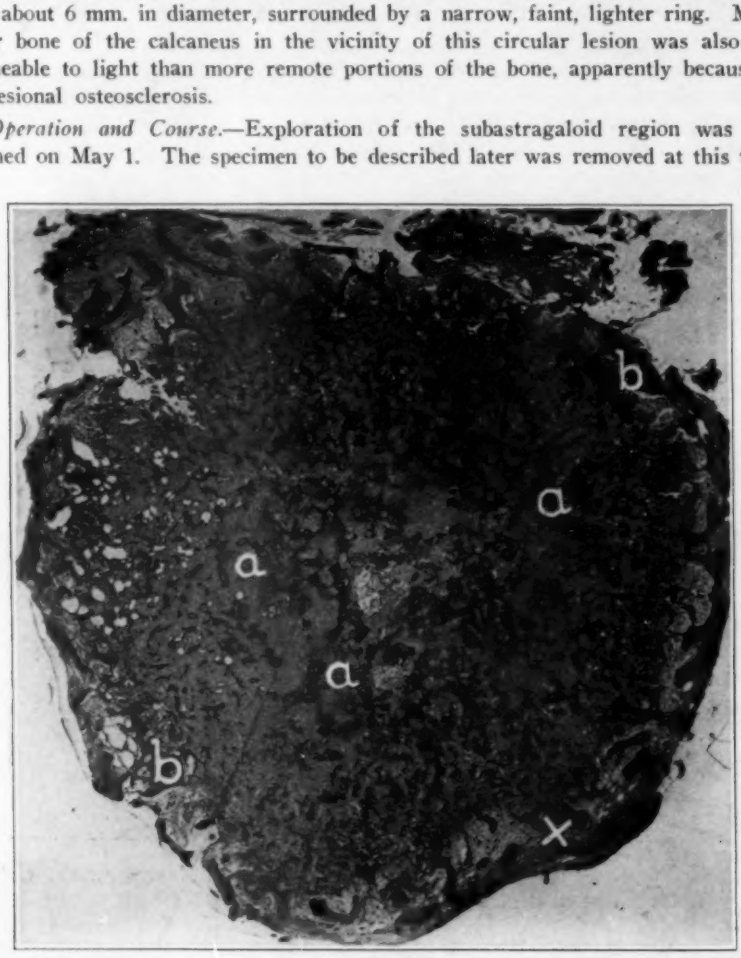


Fig. 5 (case 2).—Photomicrograph (magnification, × 15) of the lesion shown in figure 4. Note the osteoid tissue (*a*), which is heavily calcified in some places, the peripheral trabeculae of new bone (*b*) and the peripheral region (*x*).

The postoperative course was uneventful. Six months after the operation the patient still had some pain in the foot but much less than before. Five months after the operation she had acute tonsillitis, during which there was intense pain in the foot.

*Pathologic Observations.*—The general histologic appearance of the lesion was striking and characteristic (fig. 5). The circular, rather sharply delimited lesion, which appeared in the roentgenogram to be about 6 mm. in diameter, consisted almost entirely of densely compacted osteoid, much of which was in process of calcification. At the extreme periphery of the lesion a thin zone of trabeculae

was present. Between these trabeculae was loose vascular fatty and fiber marrow containing numerous blood vessels. The layer of trabeculae was encircled in turn by a thin layer of encapsulating connective tissue. The resemblance of the lesion to that found in case 1 was apparent even at first glance.

What was striking and characteristic in the lesion was the osteoid structure. The section was stained with hematoxylin and eosin. Large quantities of intercellular material staining pink were observable everywhere. This material crowded and compressed the cells. It was also apparent, however, that scattered through the osteoid mass were innumerable tiny areas in which the osteoid was in the process of being calcified and converted into a primitive type of bone (fig. 6). In the area where the conversion was taking place the vascular spaces had become

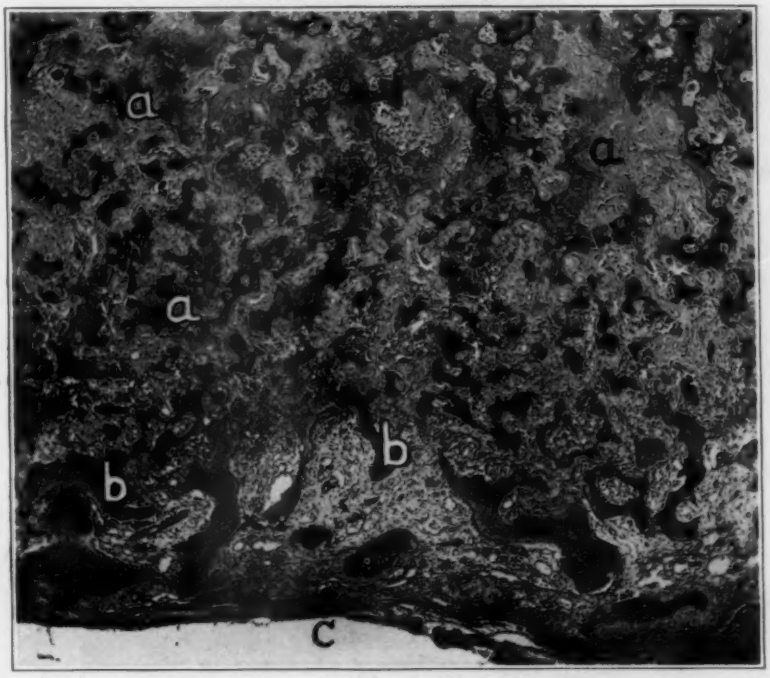


Fig. 6 (case 2).—Photomicrograph (magnification, × 50) of the peripheral region (*x*) in figure 5. Note the osteoid that is calcifying (*a*), the peripheral trabeculae of new bone which become continuous with the osteoid (*b*) and the periphery of the lesion (*c*).

more clearly delimited. Furthermore, the primitive bone already showed evidences of reconstruction, denoted by the presence of Howship's lacunae and osteoclasts. The few better developed bone trabeculae at the extreme periphery of the lesion were apparently evidences of further progress of ossification.

*Interpretation of the Roentgen Findings.*—In the light of the histologic examination it was apparent that the reason the mass of the lesion was relatively not very permeable to light was that it was composed of osteoid which in innumerable places was being calcified and converted into atypical primitive bone. The reason the perifocal bone was also relatively only slightly permeable to light was that the original trabeculae of the calcaneus had become sclerotic.

CASE 3.—*History.*—The patient was a white girl 20 years old who entered the outpatient department on Nov. 22, 1933.

For about a year the patient had pain in the middle toe of the right foot. The pain was most troublesome at night, especially when she assumed a recumbent

Fig. 7 (case 3).—Roentgenogram showing the dense, homogeneous, circular shadow in the ungual phalanx. The bone has expanded. The proximal portion of the phalanx is sclerotic.

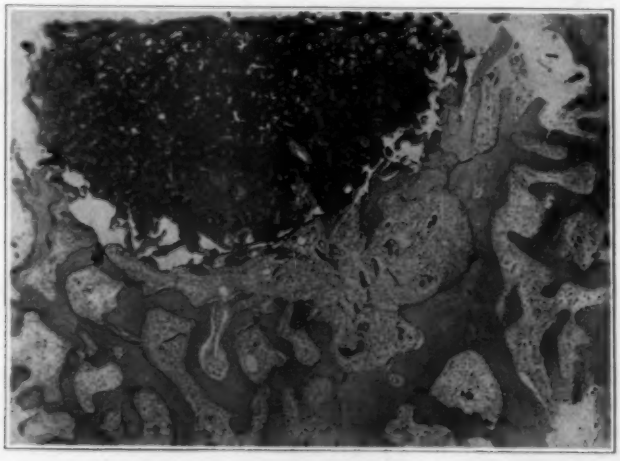

Fig. 8 (case 3).—Photomicrograph (magnification, × 15) of part of the focus shown in figure 7. It is composed of highly calcified, atypical bone which stands out clearly from the sclerosed perifocal bone.

position. Recently it had become so severe that sometimes she could not sleep. The pain was localized, nonradiating, constant, dull and aching. There was no history of injury or of fever or chills.

*Examination.*—Clinical examination revealed moderate swelling of the terminal end of the toe. The swollen tissues were firm. There was no fluctuation. The ungual end of the toe was tender, and the nail was discolored. The swelling and discoloration were apparently of recent date as compared with the duration of the pain. The results of the clinical laboratory tests were negative.

A roentgenogram taken on November 25 showed in the terminal end of the ungual phalanx a circular lesion 5 mm. in diameter (fig. 7). The pathologic area cast a dense and relatively homogeneous shadow. It was delimited from the rest of the phalanx by an annular zone comparatively permeable to light. Just proximal to the lesion the bone appeared somewhat densified. Before pathologic examination the lesion was erroneously interpreted as a sequestrum.

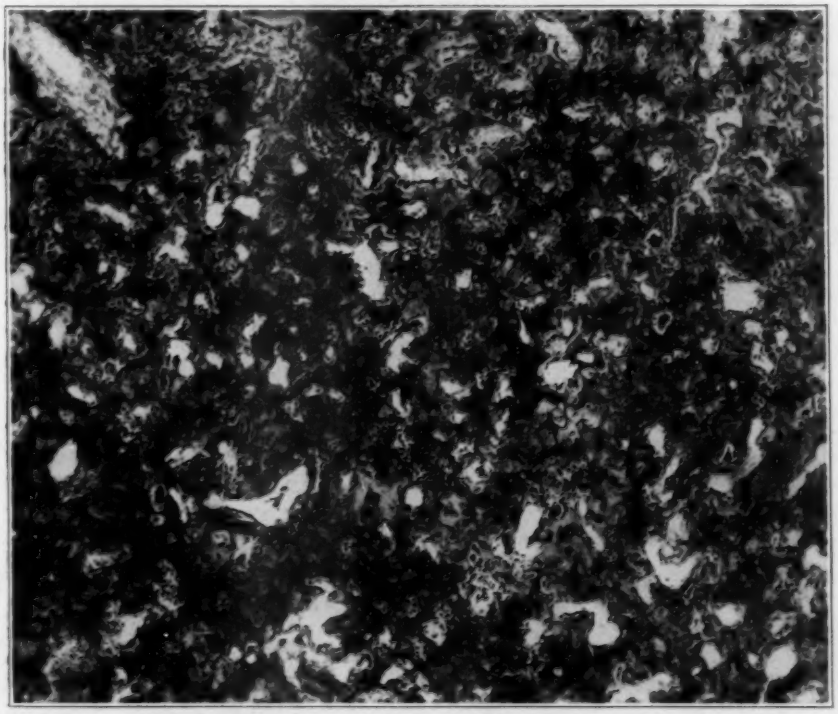

Fig. 9 (case 3).—Photomicrograph (magnification, × 125) showing details of the histologic structure of the atypical bone constituting the focus shown in figure 8.

*Operation and Course.*—An operation was performed on December 4 by Dr. Milch on the assumption that the condition was osteomyelitis of the right middle toe with formation of a sequestrum.[3] The diseased portion of the phalanx was resected.

3. After the pathologic examination of this specimen had been made, but before I had completed my study of this and similar cases, Dr. Milch published a report (J. Bone & Joint Surg. **16**:681, 1934) in which some of the data (largely clinical) concerning this case were included. He also mentioned some facts concerning cases 1 and 5 of the present series.

The postoperative course was smooth so far as primary healing and freedom from intercurrent infection were concerned. Six months after the operation, however, there was still swelling of the soft tissues of the ungual portion of the toe. Also, the tissue about the nail was still tender on pressure. The lesion has not recurred, however.

*Pathologic Observations.*—On gross examination the resected fragment of the phalanx showed a yellowish focus of changed bone. Microscopically this focus was found to be definitely circumscribed and to consist of a highly compact mesh of rather atypical and primitive bone (fig. 8). The primitiveness of the bone was evidenced in the multiplicity of the bone cells, the prominence of the bone cell lacunae and the irregularity of the arrangement of the cells. Between the meshes of bone were numerous vascular channels. These meshes were lined by osteoblasts, and reconstruction was evidenced by the presence of Howship's lacunae and osteoclasts. No hematopoietic marrow was present between the trabeculae.

The possibility was considered that the substratum of this focus of primitive bone might possibly be cartilage which had undergone direct bony metaplasia. Careful search of serial sections failed to disclose any cartilage, however. Furthermore, the cellularity of the lesion strongly indicated that such cartilage could scarcely have constituted the direct precursor of this tissue. (The primitive bone observed in this lesion reminded me of the sclerotic atypical bone seen in the metaphyses of rats which were on a diet adequate in calcium but which were suffering from chronic hyperparathyroidism.) All in all, the impression gained was that the lesion in its present state was the product of rapid ossification of the osteoid tissue, with the production of primitive bone (fig. 9). The ossification of the osteoid tissue observed in case 2 seems to shed light on the genesis of the primitive bone in the present lesion.

The perifocal original bone showed thickening of the spongy trabeculae through apposition of new bone. The intertrabecular marrow was moderately scarred, and fatty fiber marrow had appeared. The neoplastic focus, although delimited from the surrounding sclerotic bone, was again not walled off from it in any special way.

*Interpretation of the Roentgen Findings.*—The pathologic observations made it clear that the reason the circular lesion in the terminal end of the ungual phalanx cast a homogeneous dense shadow was that it was composed of a mesh of highly compact and highly calcified bone which histologically was primitive (fig. 9). There was no evidence either of osteomyelitis or of formation of a sequestrum.

CASE 4.—*History.*—The patient was a youth 16 years of age who first came to the outpatient department for treatment on Oct. 21, 1933. Four months before this the patient began to have pain in the back of the neck which was dull and nonradiating.

*Examination.*—On clinical examination it was striking that no anterior flexion of the head could be elicited beyond the neutral plane. In most other directions there was some motility, especially toward the right. The cervical portion of the spine was tender both to touch and to pressure, particularly in the region of the spinous process of the seventh vertebra. However, there was no local heat or redness, and no masses could be felt. In the course of four months of observation in the clinic the cardinal symptoms progressed; that is, the pain and inability to bend the head forward became more pronounced. Pain continued despite immobilization of the neck in a leather jacket and often interfered with the patient's sleep.

Fig. 10 (case 4).—Roentgenogram showing the circular area of rarefaction in the expanded spinous process.

Fig. 11 (case 4).—Photomicrograph (magnification, × 10) of the lesion in the spinous process shown in figure 10. Note how clearly the pathologic tissue stands out from the surrounding bone.

Roentgen examination at the time of the patient's admission to the outpatient department failed to disclose any lesion in the cervical portion of the spinal column. Four months later, however, examination of this region disclosed a circular area of rarefaction in the spinous process of the last cervical vertebra. The diseased area (fig. 10) measured about 20 mm. in diameter. About the lesion the bone of the spinous process appeared somewhat sclerosed, while that of the body of the vertebra was sclerotic to a considerable degree.

*Operation and Course.*—An operation was performed by Dr. Wishner on Feb. 26, 1934, on the assumption that the condition was osteomyelitis of the spinous process of the last cervical vertebra. This process was removed.

The postoperative course was one of slow improvement with respect to the principal complaints. Nine months after the operation flexion of the head beyond the neutral position was impossible. Hyperextension was normal, however, and the pain had considerably diminished.

*Pathologic Observations.*—On gross examination the spinous process was found ballooned out. In the expanded portion the cortex had thinned, at least in one place, to the point of incipient perforation. In the medullary space was a circumscribed lesion containing bone different from that surrounding it (fig. 11). On microscopic examination the tissue in the medullary space was found to be composed of a fine-meshed, compact network of osteoid and bone. In places the osteoid was in a process of calcification. This reticulum of osteoid and new bone was everywhere lined by osteoblasts. In Howship's lacunae on the surface of the trabeculae and between the trabeculae themselves osteoclasts were seen. The intertrabecular marrow was vascular, and the vessels were engorged. This marrow contained large numbers of osteoblasts. The lesion was definitely delimited from the original bone of the spinous process but there was no special delimiting tissue. The focus was surrounded by a zone of vascular connective tissue which was continuous with the intertrabecular marrow of the adjacent bone. This bone showed considerable resorption and numerous osteoclasts in the immediate vicinity of the intra-osseous lesion. Farther off there was definite evidence of sclerosis. In some spots actual thickening of the cortex of the spinous process through deposition of periosteal new bone had occurred.

*Interpretation of Roentgen Findings.*—This was the only case in which I was fortunate enough to have roentgenograms of the diseased region taken both before and after the pathologic condition was demonstrable in this way. The first roentgenogram failed to disclose the disease focus, although the clinical complaints were already clear. Roentgen examination four months afterward, however, disclosed the area of rarefaction already described. In the interim the clinical complaint had become aggravated. The difference between the two roentgenograms was evidence that the lesion had progressed. The reason the lesion showed as an area of rarefaction was that the osteoid was not highly calcified as it was in cases 2 and 3. In fact, on gross examination the intramedullary mass felt like an accumulation of granulation tissue.

CASE 5.—*History.*—The patient was a white youth 15 years of age who first came for treatment to the outpatient department on May 1, 1933.

The complaint was of pain in the ankle of two months' duration and of increasing severity. The pain was generally nocturnal and was sometimes severe enough to prevent sleep. It did not radiate. There was no recollection of any injury.

*Examination.*—Clinical examination revealed puffiness of the left ankle with tenderness above the external malleolus. There was distinct limitation of function in that the patient favored his left foot. The swelling was mainly in the vicinity of the external malleolus. There was slight local heat but no fluctuation or redness. Marked point tenderness was noted over the fibula about 2 inches (5 cm.) proximal to the tip of the malleolus. The clinical laboratory examinations yielded negative results.

Roentgen study revealed a roundish area relatively more permeable to light, about 1 cm. in its greatest diameter, in the medulla of the fibula. The lesion appeared as a sort of vacuole and was located approximately 1 inch (2.5 cm.)

Fig. 12 (case 5).—Roentgenogram showing the area more permeable to light in the lower end of the tibia. There have been some expansion of this bone and some deposition of periosteal new bone.

above the epiphyseal line (fig. 12). The area stood out sharply from the neighboring bone. The surrounding medullary bone was somewhat sclerosed. The distal end of the fibula was thickened in consequence of periosteal depositions.

*Operation and Course.*—An operation was performed on May 11 on the assumption that the condition was an abscess of the bone. However, no pus was found in the region explored, and pieces of tissue sent to the laboratory for culture remained sterile. The patient was discharged on June 6 but was readmitted to the hospital on June 19 because the operation had not relieved the pain, which, in fact, had become worse. Furthermore, a new roentgenogram showed that the lesion revealed in the earlier roentgenogram, had not been removed. A second

operation was performed by Dr. Reitzfeld on June 22, still on the assumption that the lesion was an abscess of the bone, but no pus was found in the diseased area, which was curetted.

*Pathologic Observations.*—Since the material submitted consisted only of small curetted fragments, no diagnostic opinion was expressed on the basis of the gross findings. Microscopic study revealed an osteoblastic, osteoid and bone-forming lesion (fig. 13). Collections of osteoblasts were observed, between which intercellular material had become deposited so that small osteoid masses were formed. In places, the osteoid showed some evidence of calcification. Both the calcifying and the uncalcified osteoid collections were definitely undergoing resorption, and

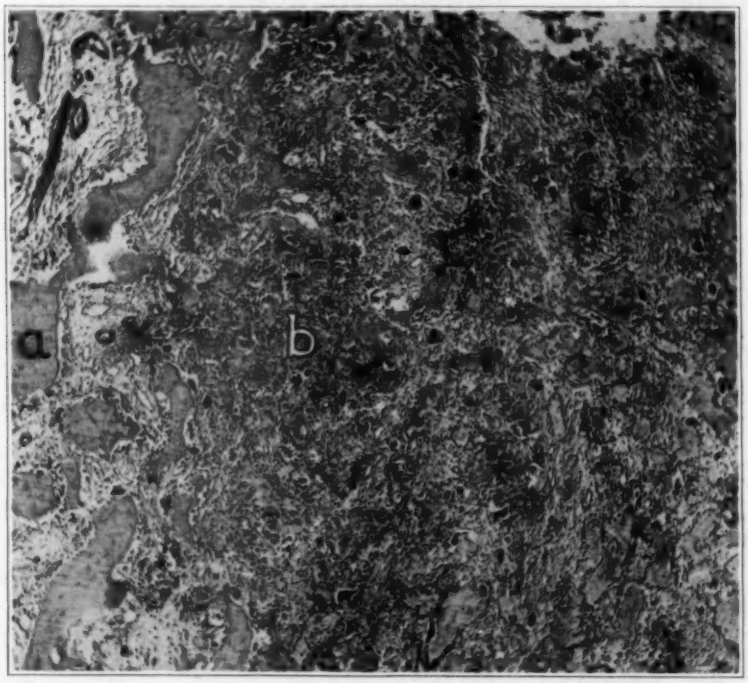


Fig. 13 (case 5).—Photomicrograph (magnification, × 65) of tissue curetted from the area of disease shown in figure 12. Note the original bone trabeculae (*a*) and cellular pathologic tissue (*b*) containing numerous osteoclasts and osteoid trabeculae, a few of which show evidences of calcification.

numerous osteoclasts were observed near and between them. The intertrabecular tissue was composed of spindle and reticular elements clearly capable of forming osteoid and bone. There was no special border zone delimiting the lesion from the neighboring original bone of the fibula, the encompassing trabeculae of which were slightly sclerosed. The osteoid aggregations in this lesion showed less calcification than did those in the cases previously described.

*Interpretation of the Roentgen Manifestations.*—As previously noted, the lesion appeared merely as a roundish area in the bone relatively more permeable to light

than the surrounding bone. This was due to the fact that the lesion was composed essentially of masses of osteoid that had not yet become calcified. It is not until calcification occurs that annular dense shadows like those observed in cases 2 and 3 are to be observed.

## COMMENT

*Possible Inflammatory Origin of the Lesion.*—It was clear from the pathologic anatomy that the condition was in no sense the result of inflammation—suppurative or granulomatous. In the first place, there were no microscopic indications of suppuration or suppurative liquefaction such as would point to pyogenic inflammation. Again, no specific or nonspecific granulation tissue was evident such as one would expect to find if the condition had arisen through inflammation. Also, no necrotic bone was revealed in any of the specimens, although one expects to find it in osseous inflammations even if clearly defined sequestrums do not appear.

The microscopic observations did not even support the assumption that an inflammation had been present, had subsided and had been healed through the formation of new bone (sclerosing osteomyelitis). If the present condition had so arisen, residua of inflammation would still be discernible since all the lesions were in the formative stage when seen. Finally, the whole general character of the microscopic pathologic observations tends to exclude the possibility that the lesions had developed from a healing inflammatory process.

*Possible Origin from an Embryonic Rest.*—The supposition that the lesions might be rests, either static or growing, can likewise be controverted. It is known that simple rests in bone do not give rise to clinical symptoms. Also, cartilaginous rests are the sort most likely to be found within a bone, and no traces of cartilage were discovered in the lesions reported on here. Furthermore, although cartilaginous rests are known to undergo bony transformation at times, resulting in enostoses, there are no clinical symptoms connected with their transformation into bone. Enostoses of this type are encountered only accidentally, either by the roentgenologist or by the pathologist. They are most likely to be found in the spongy portion of long tubular bones. They consist of normal adult lamellar bone but are distinguished from the neighboring normal spongy bone by their denser, pumice-like consistency. The character of such enostotic bone differs in every way from that of the tissue of the lesions reported on here.

*Lesions as Unfamiliar Healing Stages of Giant Cell Tumors or of Cysts.*—Pathologic examination revealed that the lesions under discussion could not be explained as the healing stage of these conditions. In the first place, if the lesions were healing giant cell tumors it was to be expected that they would still show microscopically the distinctive characteristics of such tumors, that is, a highly vascular spindle stroma,

often with an abundance of multinucleated giant cells. Furthermore, while formation of bone is not infrequently to be observed in giant cell tumors, it is never excessive nor is the appearance of bone preceded by a stage of exuberant formation of osteoid.

It would not be appropriate here to consider the relation of giant cell tumors of bone and local osteitis fibrosa to certain cysts. There are several different ways in which a circumscribed cyst of bone may arise. In any event, cystic cavities in bone are usually lined by a definite fibrous membrane. Also, the natural tendency for cysts to become obliterated through healing is slight. Intracystic ossification is not likely to occur. If a cyst is obliterated the bone pushes inward from around it, constantly reducing it. In the lesion under consideration there was no wall clearly delimiting the diseased tissue from the surrounding bone, and the core of the lesion was usually calcified osteoid or bone. It seems clear that this type of lesion cannot be regarded as a healed or healing cyst of the bone.

*The Neoplastic Nature of the Lesion.*—One feels forced to conclude that one is dealing here with a benign bone neoplasm the distinctiveness of which has not hitherto been recognized and which I am designating "osteoid-osteoma." The osteoid-osteomas so far observed have all arisen intramedullarly, in spongy bone areas. None have arisen from the periosteum or within cortical bone. I hold that this tumor arises from osteoblastic (bone-forming) mesenchyme; that it is peculiar histologically in its tendency to form rather large amounts of osteoid; that this osteoid can become considerably calcified; that new bone, largely atypical, may replace or intermingle with the osteoid, and, finally, that when trabeculae do form, the intertrabecular stroma remains highly cellular, containing numerous osteoblasts but never hematopoietic marrow or simple fatty marrow.

Roentgenographically each of the five tumors cast a small and annular shadow. In case 5 the shadow of the lesion was more permeable to light than the neighboring bone. In this case the tumor was composed essentially of uncalcified osteoid which had replaced the spongy trabeculae that would normally be present in this portion of the fibula. In my opinion this roentgenogram portrays one of the earliest visible manifestations of the lesion. The rarefaction shown in the roentgenogram signifies that the bone originally present at the site of the disease focus has been resorbed and has been replaced by osteoid. This process may be well begun, however, before it shows roentgenographically. This opinion was confirmed in case 4, in which there was considerable pain in the neck and inability to bend the head forward for several months before the spinous process showed the rarefaction induced by the tumor. When calcification and ossification have begun,

however, the roentgenogram of the lesion may show a shadow considerably darker than that of the surrounding bone; this was seen particularly in cases 2 and 3.

Among other reasons why it seems safe to regard the lesion as a neoplastic tumorous growth are the following: 1. The lesion consists of osteoid and atypical bone which without obvious cause has displaced the bone that would normally occupy the region. 2. The growth of the lesion, though slow, was independent of that of the surrounding tissues, the perifocal bone responding merely by becoming sclerosed. 3. Microscopically the tissue of the lesion differs from that of the surrounding normal bone but is itself homogeneous and consistently the same in the different cases.

As to the benignity of the tumor, this too is directly evidenced in several ways. The tumor does not perforate the periosteum or infiltrate the soft tissues in the vicinity of the bone. Also, in all these cases it was surrounded by encapsulating bone. Above all, after it had been removed it did not recur, and there were no metastases.

## LITERATURE

Search of such literature as seemed reasonably promising (including roentgenologic atlases) did not reveal any full and consistent discussion or description of the type of lesion forming the subject of the present article. Under the title "Sclerosing Osteomyelitis of Carpal Scaphoid" Dr. Hitzrot [4] presented before the New York Surgical Society on Dec. 11, 1929, a case in which the roentgenogram closely resembles those made in my first three cases. The pathologic description was extremely cursory, however, and no details were given by which the lesion might be distinguished in similar cases. As judged, however, by the annular shadow in the roentgenogram, by the history of persistent, nonradiating pain and swelling and by the fact of nonrecurrence, Hitzrot's case seems clearly to belong to the group under discussion.

There are two other reports to be considered as probably bearing on the type of lesion with which this article is concerned.[5] The first is

4. Hitzrot, J. M.: Sclerosing Osteomyelitis of Carpal Scaphoid, Ann. Surg. **91**:450, 1930.

5. In addition, I have now come across a pertinent article by J. Heine (Arch. f. klin. Chir. **146**:737, 1927). In this article he described what he regards as a bone sequestrum in the process of being reincorporated into the basal phalanx of the ring finger. The roentgenogram of this so-called sequestrum certainly resembles very closely the roentgenograms of my cases 2 and 3. The pathologic evidence which he presented does not clearly support his contention that the lesion he was discussing was an inflammatory one.

that of Bergstrand,[6] who in 1930 reported two cases of what he considered "a peculiar and probably not hitherto described osteoblastic disease in the long bones of the hand and foot." One of his patients was a girl about 16 years of age with swelling and tenderness of the right foot of fifteen months' duration at the time of operation. A lesion of the metatarsal bone was known to have been in existence for at least thirteen months when operated on, and although the lesion did not enlarge during this time, it had become more painful since first noted. On roentgen examination the bone was found to have undergone spindle swelling. There was periosteal new bone formation; the underlying cortex was retained, and the marrow canal was partially obliterated. The entire diaphysis of the metatarsal bone was resected, and the patient made a complete recovery. The second patient was a boy 18 years of age. For two years there had been increasing thickness of the left middle finger. Roentgenologic examination revealed a destructive lesion in the distal half of the diaphysis of the basal phalanx. The phalanx was removed, and there was no recurrence during the succeeding three years. Pathologic examination in the two cases revealed eccentrically located disease foci situated, respectively, in the proximal portion of the diaphysis of the metatarsal bone and in the distal portion of the diaphysis of the phalanx. The disease focus, which in each case was the size of a pea, showed a center which consisted of amorphous collagenous material.

Bergstrand was at a loss to classify this condition. He held that it was neither a tumor nor an inflammatory process. He conceived the lesions as having arisen through a local disturbance in the formation of bone, tracing this disturbance back to embryonal life. Although no cartilage cells were observed on pathologic examination, he believed that the homogeneous intercellular material most closely resembled the intercellular material of cartilage, and that it had resulted from embryonal cartilage that had undergone regressive change leading to loss of its cells. He was of the opinion that the lesions would have healed spontaneously and the center of the focus would have been transformed into bone had they not been operated on.

Mayer and I[7] described an "osteoblastic osteoid tissue-forming" lesion of the metacarpal bone which, especially microscopically, showed a strong basic similarity to the lesion described by Bergstrand. The latter exchanged slides with me and like myself was definitely of the opinion that essentially we were dealing with the same condition. How-

6. Bergstrand, H.: Ueber eine eigenartige, wahrscheinlich bisher nicht beschriebene osteoblastische Krankheit in den langen Knochen der Hand und des Fusses, Acta radiol. **11**:597, 1930.

7. Jaffe, H. L., and Mayer, L.: An Osteoblastic Osteoid Tissue-Forming Tumor of a Metacarpal Bone, Arch. Surg. **24**:550 (April) 1932.

ever, the lesion described by Mayer and me had progressed to a stage at which its tumorous character could no longer be questioned even clinically. The lesions in Bergstrand's cases, on the other hand, were still so circumscribed that he rejected the idea of their being tumors. In my opinion, however, they were tumors not only resembling the metacarpal tumor described by Mayer and myself but also possibly related to the lesions of the five cases described in the present article.

The "osteoblastic osteoid tissue-forming" metacarpal tumor seen and described by Mayer and me began when the patient, a girl, was 12 years old. At first it grew slowly. A biopsy was performed shortly after the tumor was first noticed by the patient. Microscopic examination revealed a richly cellular osteoblastic tissue which in places contained large deposits of intercellular material. The osteoid nature of the tissue at the sites of such deposits was clear. Growth of the lesion continued to be slow for the next two years, when growth suddenly became very rapid, destroying the entire metacarpal bone. After it had grown rapidly for about six months the tumorous tissue was extirpated. An encapsulated mass measuring 10 by 6.5 by 6 cm. was removed. In spite of the size of the lesion there had been no penetration of the periosteum. A conspicuous and peculiar microscopic feature of the tumor was the presence of considerable amounts of osteoid tissue, much of which showed no trace of calcification. There was complete absence of cartilage, cartilaginous elements and tumor giant cells. There has been no recurrence five years after resection of the tumor.

It must be conceded that there are conspicuous discrepancies between this metacarpal tumor and the present group of five lesions. Despite these differences, however, microscopically the tissue of the metacarpal tumor continued to resemble in a general way (as it did in the biopsy specimen) the pathologic tissue both in Bergstrand's cases and in the five smaller lesions herein described. It is this resemblance (along with the absence of recurrence up to five years after resection of the tumor) that makes me believe that the metacarpal tumor described by Mayer and myself was of the same nature as the lesions in Bergstrand's cases, in spite of the fact that he does not regard those in his cases as tumors. Furthermore, the osteoid character of the metacarpal tumor confirmed the suspicion that despite the special clinical symptoms which it created this tumor is related to the smaller and less exuberant lesions described in the present article. It is quite conceivable that some of the smaller lesions, if left to themselves, might ultimately also have come to show the sudden florid growth so striking in the metacarpal tumor and, vice versa, that at an earlier stage this tumor may have been small and circumscribed like the others.

## SUMMARY AND CONCLUSIONS

Clinical, roentgenologic and pathologic details concerning five cases of a peculiar bone neoplasm have been presented. Analysis of these cases has led me to denote this lesion osteoid-osteoma and to single

it out in this way as a distinctive, not hitherto classified, type of bone neoplasm. It is a benign osteoblastic tumor composed of osteoid and atypical bone. In the cases seen it always arose intramedullarly in spongy bone areas.

All the patients were either adolescents or young adults. In every case the principal complaint was of local pain. As observed by roentgenogram, the pathologic areas were roundish and rather small. Complete eradication resulted in the eventual disappearance of all symptoms.

It has been shown that the lesion had no features suggesting an inflammatory origin or origin from an embryonic rest or that it represented an unfamiliar healing stage of a giant cell tumor, localized osteitis fibrosa or cyst. Despite the fact that the lesion of osteoid-osteoma remained small and globuloid in these five cases, the character of the pathologic tissue in the more diffuse tumor previously described by Mayer and me suggests that the latter lesion may be related to the type of tumor under discussion. Furthermore, it also seems likely that the lesion which was described by Bergstrand as being of embryonic origin and which he regarded as neither an inflammatory process nor a tumor is likewise related to the lesion herein designated as osteoid-osteoma.

---

## CORRECTION

In the article by Dr. Eldridge H. Campbell Jr., entitled, "Acute Abdominal Pain in Sickle Cell Anemia," in the October issue (ARCH. SURG. **31**:607, 1935), "better risk" in the penultimate line on page 619 should read "greater risk."

# MILD ACUTE APPENDICITIS

## APPENDICAL OBSTRUCTION

ORAN I. CUTLER, M.D.
LOMA LINDA, CALIF.

The question as to what chronic appendicitis is and whether it ever exists has long since become trite. That there is a clinical entity consisting of a chronic disorder of the appendix is believed by most surgeons. Many appendixes continue to be removed because of so-called "chronic appendiciţis." If there were no virtue in this practice one would expect it to present indications of ceasing to be the vogue. Statistics compiled from studies of the after-histories of patients whose appendixes have been removed because the organs seemed to be chronic disturbers of the peace lead to various conclusions. Enough favorable reports [1] have been given and sufficient observations have been made in their own practices to encourage the majority of surgeons to continue to remove appendixes because of chronic complaints. This is in spite of the fact that surgeons [2] as well as pathologists freely admit that definite chronic inflammation of the appendix is uncommon.

In order to understand better why there may be benefit from removal of appendixes showing little evidence of inflammation I have compared the complaints of a group of patients with the findings at operation and the condition of the appendixes removed. The series of appendixes studied consists of 344 removed in the past few years in one hospital. This series represents cases of frankly acute inflammation of the appendix and a number of cases in which the appendix was removed as a routine at operation on some other organ as well as cases of so-called chronic appendicitis. The last cases will hereafter be referred to as the chronic group. The observations made in the study of each of the different classes of cases will be recorded separately and afterward briefly correlated. The series of appendixes removed as a secondary consideration at the time of other operations has been used as a control group and will be referred to by that designation.

### CHRONIC APPENDICITIS

The indications [3] which have been put forth as evidences of the presence of chronic inflammation of the appendix are numerous. The

From the Department of Pathology, College of Medical Evangelists.

1. Block, F. B.: Chronic Appendicitis: A Study of End Results, M. J. & Rec. **134**:448 (Nov. 4) 1931.

2. Dickson, W. M.: Chronic Appendicitis, Brit. M. J. **1**:184 (Feb. 3) 1934.

3. Letulle, M.: Surprises de l'appendicite chronique, Presse méd. **35**:1521 (Dec. 14) 1927.

situation is reminiscent of that of certain diseases for which no specific treatment has been found. The abundance of suggested signs of chronic appendicitis indicates that none of them is outstanding in cases ordinarily studied. If true chronic inflammation of the appendix exists the evidences of the activity must customarily be slight or they would be more easily recognized. Accordingly the series of chronic cases studied was expected to show little or no evidence of actual inflammatory phenomena.

Among the 344 cases studied there were 103 in which the appendix appeared to be the seat of trouble but in which it presented slight or no evidence of active inflammation. On examination it was found that many of the appendixes presented increased quantities of scar tissue in various layers, particularly, the submucosa. Some presented complete obliteration of their lumens. The scarring may be taken as evidence of previous inflammation, but is not to be regarded as an indication that inflammation was active when the appendix was removed. The presence of a few lymphocytes about the blood vessels in the outer layers might be taken as an indication of mild chronic irritation. This finding was observed rather frequently. Atrophy of lymphoid tissue was noticed many times.

The most constant and therefore most impressive evidences of abnormality in the 103 appendixes were indications of disturbed function rather than of inflammation. The name "appendicosis" [4] has been suggested for noninflammatory conditions in the appendix which are accompanied by clinical signs of what is commonly called "chronic appendicitis."

Before the appearances of the appendixes in the chronic group are discussed further a few clinical observations may be given. These will serve to accentuate somewhat the fact that the conditions treated were functional rather than inflammatory.

The almost universal complaint of the patients given a diagnosis of chronic appendicitis was of pain and more or less tenderness in the region of the appendix. The pain was more diffuse in some cases, and in a few, localized in the upper part of the abdomen. The pain was associated with nausea in 52 of the 103 patients; 22 had vomited at times. Pain, nausea and vomiting in most cases came in attacks lasting a few days at intervals of weeks or months. In some cases the complaints were almost continuous. Previous attacks were recorded in the histories of 95 of the patients. The average number of attacks was 5. The period during which attacks had been occurring varied from 2 weeks to 25 years, the average being 3.5 years.

4. Steinberg, B.: Degenerative Lesions of the Appendix (Appendicosis) Hitherto Undifferentiated from Appendicitis, Am. J. Clin. Path. **1**:339 (July) 1931.

The average temperature recorded as the patients entered the hospital was 98.6 F. The white blood cell counts taken just before operation varied from 3,600 to 13,500. The average count was 7,960 with an average neutrophil percentage of 59.7.

Nearly twice as many females as males were included in the group, there being 67 of the former and 36 of the latter. The age of the males varied from 13 to 62 with an average age of 32.8 years. Twenty of the 36 males were between 20 and 35 years of age.

The females varied in age from 9 to 54 years with an average age of 25, which is appreciably less than the average age of the males in this group. Thirty-four of the 67 females were between 19 and 29 years of age.

Twenty-nine of the 103 patients were having active attacks of pain with more or less vomiting and nausea at the time they were brought to the hospital for operation. The average duration of these attacks before operation was 3 days. The leukocyte counts taken just before

TABLE 1.—*Compression of Mucosa and Size of Lumen*

| | | Compression with | | | |
|---|---|---|---|---|---|
| | No Compression | Small Lumen | Medium-Large Lumen | Large Lumen | Obliterated Lumen |
| Chronic group | 21 | 10 | 22 | 42 | 8 |
| Control group | 56 | 12 | 11 | 16 | 27 |

operation in these 29 cases varied from 9,900 to 12,300 with an average of 8,640. The neutrophil percentage averaged 66.

The most outstanding morphologic indication of functional disorder in this group of 103 appendixes consisted of obvious compression of the mucosa, particularly in the distal portion of the organ. The compression was shown by shortening of the columnar cells on the surface of the mucosa and shortening and tortuosity of the crypts in the areas involved (fig. 1). In 42 of the 103 appendixes studied the compression of the mucosa was associated with marked dilatation of the lumen and thinning of all layers of the walls (table 1). In the control group in which the appendix was removed at the time of performance of other seemingly more important operative procedures, compression of the mucosa was observed in some of the appendixes. Pronounced degrees of compression and dilatation of lumens were much less common in this group. The control group, which was selected from consecutive cases, was built up until there were as many appendixes having patent lumens in it as were found in the chronic group.

Considerable study of the significance and mode of production of dilatation of appendical lumens has been made by various observers.

Activity of the vagus is said to cause shortening of the organ and constriction of the proximal or ampullar portion of the lumen.[5] The muscularis of this part of the organ is commonly thicker than that of the more distal portions. That spasm of the ampullar portion may be prolonged and promote retention of feces in the distal portion has been demonstrated by roentgenologic studies.[6] Thirty of the 103 appendixes showing chronic inflammation which are discussed in this paper had been examined roentgenologically. Twenty of these remained filled 48

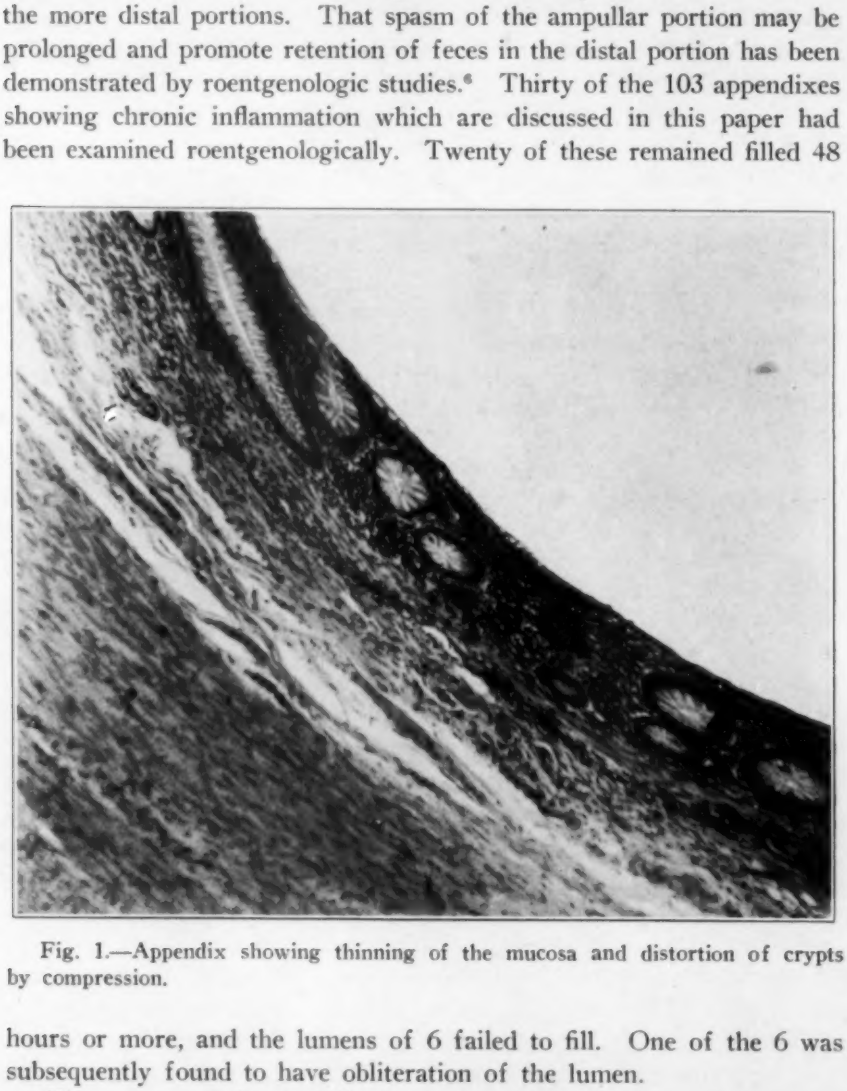

Fig. 1.—Appendix showing thinning of the mucosa and distortion of crypts by compression.

hours or more, and the lumens of 6 failed to fill. One of the 6 was subsequently found to have obliteration of the lumen.

That spasm of the ampulla is not the only factor preventing proper emptying and favoring dilatation of the lumen of the appendix seems evident. Many appendixes showing these changes also presented scar-

5. Westphal, K.: Appendizitis und Kotstein als Folge gestörter Appendixfunktion, Deutsche med. Wchnschr. **60**:499 (April 6) 1934.

6. Krenn, L.: Was leistet die Röntgenuntersuchung des Wurmfortsatzes? Wien. klin. Wchnschr. **47**:778 (June 22) 1934.

ring and contraction of the submucosa proximal to the dilated portions.[7] Irregular and multiple constrictions were often observed.

It may readily be imagined that attempts to empty themselves on the part of appendixes having functional or mechanical obstruction may result in attacks of pain or appendical colic.[8] It should be recognized that kinks and adhesions or other external causes of obstruction may also cause appendical colic.[9] In the series reported here a large number of the appendixes presenting dilatation of their lumens were more or less mechanically obstructed by adhesions, peritoneal bands and kinks. However, a comparison of tables 1 and 2 shows that a practically equal proportion of the appendixes in which dilatation was slight also presented external causes of obstruction. This leads one to make the suggestion that factors within the appendix such as spasm and scarring may be more important than external causes of obstruction, at least, in many cases. It is to be noted that the latter are more frequently recorded as present in the cases of chronic appendical disorder than in the control group.

TABLE 2.—*Presence of Adhesions, Peritoneal Bands and Kinks*

| | With Dilatation | Without Dilatation | With Obliterated Lumens |
|---|---|---|---|
| Chronic group | 35 | 14 | 8 |
| Control group | 4 | 5 | 8 |

It is easy to believe that a disordered appendix which has difficulty in emptying itself may have reflex effects on other parts of the gastro-intestinal tract.[10] This doubtless explains the nausea and vomiting which are frequently present. In the study of the control series of cases reported in this paper I attempted to correlate the presence of pathologic changes elsewhere along the gastro-intestinal tract with signs of obstruction of the appendix. In the control series there were a number of appendixes which had been removed as a secondary consideration from patients having peptic ulcers or other pathologic conditions of the alimentary canal. Many of these appendixes presented dilated lumens but the number studied was not sufficient to lead to definite conclusions.

7. Williams, B. W., and Boggon, R. H.: The Mechanics of Appendicitis, Lancet **1**:9 (Jan. 6) 1934.

8. Koster, H.: Chronic Appendicitis, Arch. Surg. **16**:44 (Jan.) 1928.

9. Bigelow, W. A.: A Study of Right-Sided Abdominal Pain in So-Called Chronic Appendicitis, Canad. M. A. J. **23**:22 (July) 1930.

10. Friedricks, A. V.: The Etiology and Pathology of Appendicitis, New Orleans M. & S. J. **87**:20 (July) 1934.

It is, of course, generally recognized that appendical colic is not the only common cause of pain in the lower part of the abdomen in the absence of fever and leukocytosis.[11] The fact that females are practically twice as numerous as males in the group of cases under consideration here bears mention. Rupture of small ovarian cysts may simulate acute appendicitis.[12] It appears probable that in some cases pain might be present repeatedly and simulate appendical colic. The large number of women in this series who were between 19 and 29 years of age when operated on is of interest, as this is a period of life when ovarian activity is pronounced. There were 8 appendixes in the series of 103 which failed to show evidences of obliteration or mechanical or functional obstruction of the lumens. Six of the 8 appendixes were from women who were from 16 to 25 years of age.

A few words concerning appendixes in which the lumens were completely obliterated might be of interest. In the chronic group of 103 appendixes 8 such organs were found. In the control group of 122 appendixes 27 appeared. About each of the 8 appendixes in the chronic group adhesions were found. These may well have been a cause of distress.[13] It seems illogical for a pathologist to censure a surgeon who removes an appendix from a patient who is having acute distress only to find the lumen of the organ closed. Search of the histories of the 35 patients having obliterated appendical lumens failed to be very fruitful in the demonstration of probable previous attacks of acute appendicitis. The average age of the patients when the appendixes with obliterated lumens were removed was 41.4 years.

### ACUTE APPENDICITIS

Active inflammation could be demonstrated in 119 of the 344 appendixes discussed in this paper. The 119 appendixes may be divided readily into three groups: 77 which were subject to frankly acute purulent inflammation, 8 in which healing processes were in evidence and 34 in which the inflammatory process was mild or early. More detailed attention will be paid the latter group because of its relation to what pathologists have at times chosen to call "chronic appendicitis."

---

11. Deal, Don: Non-Surgical Chronic Abdominal Pain, Illinois M. J. **65**:149 (Feb.) 1934.

12. Boggon, R. H., and Wrigley, A. J.: Rupture of Ovarian Blood-Cysts Simulating Acute Appendicitis, Lancet **2**:1068 (Nov. 14) 1931. Meigs, J. V., and Hoyt, W. F.: Rupture of the Graffian Follicle, the Corpus Luteum and Small Follicle or Lutein Cysts Simulating Appendicitis, Am. J. Obst. & Gynec. **25**:532 (April) 1933.

13. Horsley, J. G., and Warthen, H. J., Jr.: The Pathogenesis and Symptoms of Chronic Obliterative Appendicitis, Ann. Surg. **96**:515 (Oct.) 1932.

*Frankly Acute Appendicitis.*—A few statistics concerning the series of 77 frankly acute cases will be given briefly. The average duration of illness before coming to the hospital for the patients who recovered was 29.2 hours. Thirteen of the 77 patients died in the hospital, while none of the patients with early inflammation, to be considered separately, succumbed. The patients who died had waited on the average 69.9 hours before coming to the hospital. This long period is in accord with the observations of others.[14] Sixteen of the 77 patients gave histories of previous attacks. The average temperature on entry into the hospital was 99.8 F. Preoperative total leukocyte counts averaged 17,500 with a neutrophil percentage of 84.8. In the fatal cases the figures were 18,733 and 85.4, respectively. In 10 cases the total white cell counts were below 13,000. In these cases in particular the use of the Schilling count proved of aid [15] in indicating that an infection was present. Seventeen of the appendixes contained definite fecaliths and many others contained fecal masses as well as pus. The average age of the patients who survived was 25.46 years, and that of the patients who died, 37.9 years. Five of the fatal cases were in patients over 50 years of age. Four were 14 or less. An attempt was made to correlate the incidence of appendicitis with climatic conditions. Definite observations were not possible, but in each of the years during which the cases occurred the incidence was a little higher in the warmer months.

*Healing Acute Appendicitis.*—Eight of the patients were operated on at a time when the appendix presented indications of the presence of healing. The walls were thickened, but not so much by purulent exudation as by edema and early formation of scar tissue. The latter was present mainly in the serosa and submucosa. The mucosa showed various degrees of repair of ulceration. All layers contained abundant eosinophils. It has been pointed out that eosinophils in the mucosa are not an indication of inflammation,[16] but when present in other layers they signify a healing process. A prolongation of this process might be regarded as a true chronic appendicitis, analogous to the chronic salpingitis which so frequently follows the acute phase of infection of the fallopian tubes. While after acute inflammation has been present healing of the appendix may at times require a few weeks, the process seems very seldom to be retarded as it so frequently is in salpingitis. The possibility of drainage into the cecum before scarring occurs may be the explanation of this fact.

---

14. Bower, J. O.: Appendicitis in Philadelphia, J. A. M. A. **102**:813 (March 17) 1934.

15. Warnock, F. B.: Leucocyte Count and Histopathology in Acute Appendicitis, Am. J. Surg. **21**:47 (July) 1933.

16. Butka, H. E.: Chronic Appendicitis, California & West. Med. **26**:467 (April) 1927.

The 8 patients in this group had been ill an average of 11 days before operation. Their temperatures on entry into the hospital averaged 99.1 F.; the white counts, 13,400, and the neutrophil percentage, 72.5. The total white counts varied from 6,800 to 31,000. The two highest counts were on blood from patients having abscesses about their appendixes. All the patients of this group recovered.

*Early or Mild Acute Appendicitis.*—This group of cases, which numbered 34, is of especial interest. Careful consideration of the appendixes brings forth the observation that relatively slight inflammatory changes may be associated with definite clinical evidences of appendical disease. Furthermore, the observation may be made that great variation in the severity of the lesions of acute appendicitis is possible.

Most of the patients in this group were having acute attacks at the time their appendixes were removed. However, in nearly one half of these patients the attacks were so mild that the surgeons considered that they were dealing with exacerbations of so-called chronic appendicitis. The reason for consideration of these patients together in one group is the similarity of the pathologic pictures present. This will be discussed again later.

TABLE 3.—*Temperatures and Leukocytes Counts with Different Types of Appendicitis*

| Type of Appendicitis | Preoperative Temperature, F. | Leukocytes | Neutrophil Percentage |
|---|---|---|---|
| Chronic | 98.6 | 7,060 | 59.7 |
| Mild acute | 99.3 | 12,900 | 80.0 |
| Frankly acute | 99.8 | 17,500 | 84.8 |
| Healing acute | 99.1 | 13,400 | 72.5 |

Pain was the most universal complaint of all of the 34 patients. Thirty had nausea and 24 had vomited. Illness had been present for from 3 hours to 5 days before operation. The average duration of complaints before operation was 40 hours. This fact considered with the type of pathologic process present indicates that the disease was present in a relatively mild form in the patients who had been ill more than 1 or 2 days. In some cases the mildness of the lesions found is explained by the early removal of the organ. Eleven patients were ill less than 12 hours before operation, and 9 others had been sick less than 24 hours. A record of previous attacks was found in the histories of 17 of the patients. The average time which had elapsed since the first attack was 3.5 years and the average number of attacks which had been suffered by these 17 patients was 3.

The average temperature recorded on entry into the hospital was 99.3 F. The total leukocyte counts varied from 5,400 to 29,250 with an average of 12,900. The neutrophil percentage averaged 80 (table 3).

In the cases in which the total counts were low attention to the neutrophil percentage and the Schilling count was of definite value in indicating the presence of an infectious process. Ages varied from 6 to 36 with an average of 25.4 years. Eighteen patients were between 20 and 25 years old.

The basis on which this group of cases was selected for separate consideration was the type of pathologic process present. Congestion and edema were observable grossly. In some cases the lumens of the appendixes contained purulent material more or less mixed with feces and mucus. No ulcerations of the mucosa were observable with the naked eye. With the aid of the microscope occasional tiny ulcerations were found. Some of these, as in cases studied by Steinberg, were surrounded by relatively little cellular reaction. Moderate numbers of neutrophils were found in the mucosa. These were usually in small areas which might be missed if only one portion of the appendix were studied. Very few, and in many cases, no leukocytes were found in the outer layers.

Examination of the lymphoid tissue discloses the most readily discoverable indications of early and mild acute inflammation of the appendix. Neutrophils appear in the lymphoid tissue practically as quickly as they do in the mucosa. This frequently renders the lymphoid tissue the easiest place to find indications of mild acute appendicitis. The most readily noticeable feature of the lymphoid tissue in the early lesions is the presence of large phagocytes which have ingested damaged leukocytes (figs. 2 and 3). These cells are found in the germinal centers. Their abundant pale cytoplasm gives the germinal centers a vacuolated or spongy appearance as seen by low power magnification. The presence of these active phagocytes was the most constant indication of acute infection found in the 34 appendixes of this series.

The fact that the infiltrating cells are neutrophils and the absence of scarring indicate that the process described is acute rather than chronic. From a clinical view this conclusion seems rational because of the relatively short duration of the individual attacks of pain and their tendency to be accompanied by elevation of temperature and of the leukocyte count.

By way of comparison a study of the lymphoid tissue of the appendixes of the chronic and control groups was made. In the chronic series of 103 cases, 95 appendixes were found with lumens patent. In 14 of the 95 the lymphoid tissue was practically devoid of germinal centers. Fifty-one appendixes contained germinal centers in which few or no phagocytes were found. In the remaining 29 appendixes active phagocytes were present in the germinal centers but in definitely smaller numbers than in the series of 34 cases just discussed.

The patients whose appendixes presented no germinal centers had an average leukocyte count of 7,260. For the group whose appendixes presented germinal centers but no phagocytes it was practically the same, being 7,790. The 29 patients in whose appendixes the germinal centers contained some phagocytes tended to have higher white counts. These counts varied from 3,600 to 12,300 with an average of 9,500. Thirteen of the counts were above 10,000. Neutrophil percentages varied from 54 to 91 with an average of 66. Seventeen of the 29 patients were

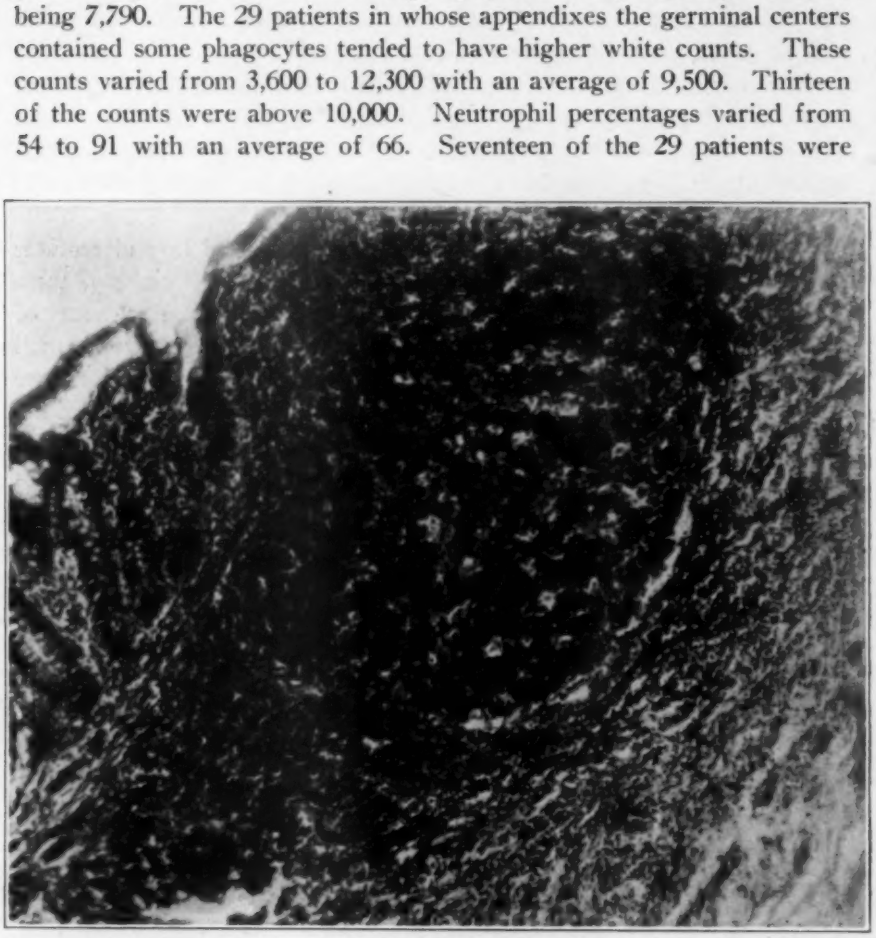

Fig. 2.—Low magnification of a germinal center of the lymphoid tissue of an appendix. Note the active phagocytes having much clear cytoplasm which are scattered in the germinal center.

having acute attacks of pain when operated on. Because of the mildness of the attacks, all were regarded as having only chronic appendicitis clinically. If one accepts the presence of moderate numbers of neutrophils in the germinal centers and the presence of a few active phagocytes as evidence of acute inflammation of mild nature this group is not separable from the series of 34 cases of mild acute appendicitis discussed in the foregoing paragraph. The decision to consider the 29 cases with the chronic group was an arbitrary one based on the fact

that the evidences of inflammation, though present, were slight. The concept that many apparent attacks of chronic appendicitis may be in truth very mild degrees of acute appendicitis appears to me to be worthy of consideration. In many cases of mild acute appendicitis the signs may be so slight that a correct diagnosis is difficult.[17]

The control series of 95 appendixes with patent lumens included 13 in which no germinal centers were found. Seventy-seven presented germinal centers but no phagocytes. In 5 of the appendixes of the control series moderate numbers of active phagocytes were found in

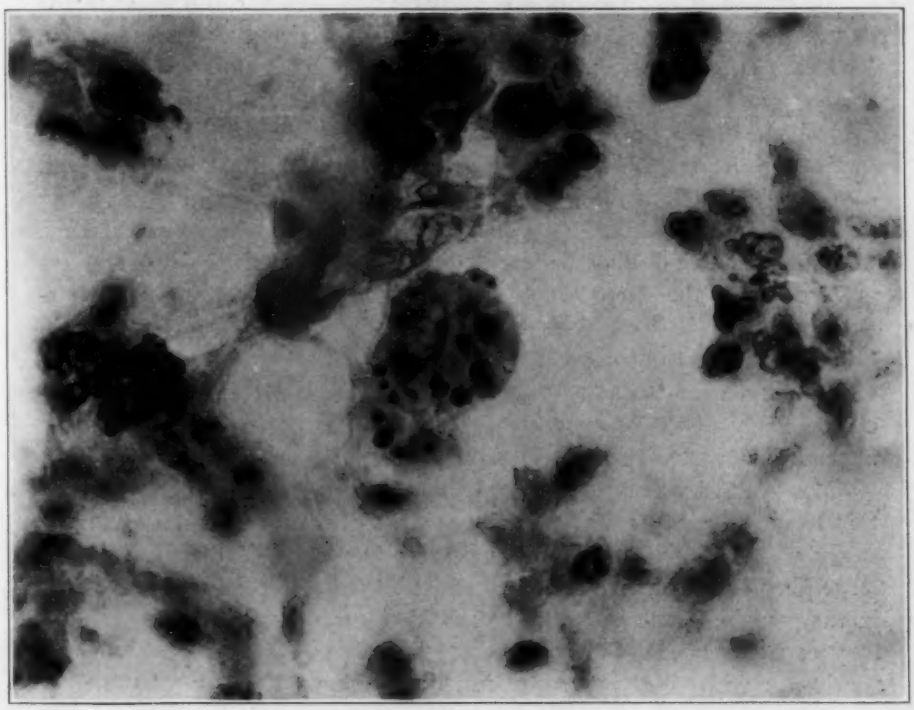

Fig. 3.—High magnification of one of the active phagocytes shown in figure 2. It has ingested fragments of neutrophils.

germinal centers. As the patients were suffering from conditions other than appendicitis for which surgical operations were performed clinical indications of mild degrees of appendicitis were obscured.

The relationship of appendical obstruction to mild acute appendicitis remains to be considered. In the series of 34 appendixes discussed under the heading of mild acute appendicitis 20 presented definite evidences of failure to empty properly. Adhesions or other external causes

17. McClure, R. D.: Chronic Appendicitis, Ann. Surg. **94**:203 (Aug.) 1931.

of obstruction were present in 8 of the 20 cases. In 14 appendixes evidences of delayed emptying were not recognizable. Of the 29 appendixes considered with the chronic series but in which some active phagocytes were found, evidence of obstruction was present in 20. The conclusion may be made that mild degrees of acute appendicitis frequently occur in obstructed appendixes, but that definite evidences of obstruction may be lacking when mild inflammation is found.

## SUMMARY

Failure of the appendix to empty properly is a common cause of repeated attacks of pain in the right lower quadrant of the abdomen. The pain is frequently associated with reflex nausea and vomiting. In many cases the cause of obstruction is spasm of the muscularis of the ampulla of the appendix. Elevation of temperature and of leukocyte count appears not to occur unless acute inflammation is also present. Until some better method of relief of obstruction is found the practice of removal of obstructed appendixes is warranted. Appendical colic due to obstruction may be most distressing. Obstructed appendixes are frequently the site of acute inflammation, although this may apparently occur in the absence of marked or long-standing obstruction. When appendical obstruction is the cause of attacks of pain the attacks may be more frequent than when the illness consists of acute appendicitis. Study of the control series indicates that some patients may have appendical obstruction and complain relatively little of it.

Many attacks of acute appendicitis are very mild. The inflammation frequently involves only the inner coats of the appendix. The most easily observed evidence of mild acute appendicitis is the presence of large phagocytes which have ingested leukocytes. These cells are found in the germinal centers of the lymphoid tissue. Repeated mild attacks may conceivably cause thickening of the submucosa and narrowing of the lumen with resultant appendical obstruction. Further attacks may result in obliteration of the lumen. That severe attacks of acute appendicitis are not necessary in order that the lumen may be obliterated is shown by the fact that the outer layers of appendixes in which the lumens are obliterated seldom show very marked scarring.

Since attacks of acute appendicitis are frequently very mild, many are unrecognized. When clinical signs of acute appendicitis are present it is not possible to predict with accuracy the appearance of the appendix at operation. Many appendixes removed early in the course of illness present surprisingly little pathologic change. This may lead to errors of interpretation by pathologists who may accuse surgeons of removal of normal appendixes. Further search in such cases will frequently reveal the indications of early acute inflammation discussed. In other

cases mild acute appendicitis is erroneously diagnosed as chronic appendicitis by the surgeons who operate on the patients. Study of the blood count, particularly the Schilling count, is of definite aid in gaging the severity of the condition. Mortality figures are very low when appendixes are removed while the attacks are still mild. Since it is not possible to predict accurately the course of events in the appendix, early operation is to be urged.

## CONCLUSION

The vermiform appendix is frequently the seat of chronic or recurrent disease. So-called chronic appendicitis usually consists either of appendical obstruction or of recurrent attacks of mild acute appendicitis.

In making a diagnosis of chronic or recurrent appendical disorder other causes of abdominal pain, such as ovarian changes in the female, must be considered.

The lesions produced by mild acute appendicitis may be so slight as to be readily overlooked on examination of the organ.

# PILONIDAL SINUS

## SURGICAL TREATMENT AND PATHOLOGIC STRUCTURE

HORATIO ROGERS, M.D.
AND
MARSHALL G. HALL, M.D.
BOSTON

It is our purpose in this paper to present the clinical and pathologic data on which are based our views on the treatment of pilonidal sinus. The question of etiology, though unsettled, will not be considered here. The clinical picture is a familiar one, and its description needs no repetition. The conception of the disease on which most surgical treatment is based, however, will be discussed at some length.

### CURRENT CONCEPT OF MORPHOLOGY

It has been commonly believed that the presence of a recurrent or persistent sinus after excision implies that some of the diseased tissue must have been left behind. This belief has naturally led to increasingly radical excisions in an attempt to remove all the diseased tissue at one operation. The frequency of recurrence and persistence of the sinus in spite of such operations has given rise to the impression that a pilonidal sinus consists of a complex network of ramifying branches of unknown extent. This concept has been strengthened by the appearance often produced when methylene blue or another dye is injected into the sinus. Fine tubular structures filled with dye have been regarded as radiating branches of the pilonidal sinus system.

### TREATMENT BASED ON CURRENT CONCEPT

The radical excisions resulting from this concept have led to new problems. The novice finds it difficult to resist the temptation to perform an immediate midline closure of the skin. The dead space formed by such a closure invariably fills with clotted blood, which may or may not become infected, the result being usually a broken-down wound, a persistently draining sinus or both. The partial closure of the wound with the inclusion of a drain leads to the same result. Although it is now commonly recognized that many sinuses so produced contain no hair or other epithelial elements and are in reality artefacts resulting

From the Surgical and Pathological Services of the Massachusetts General Hospital.

from a combination of dead space and chronic infection, the problem they present is as troublesome as if they were true recurrences.

It is chiefly toward meeting this and other difficulties growing out of the acceptance of an original radical excision that the ingenuity of investigators has been directed. Their efforts are all variations of two main plans: (1) to keep the wound open either by packing or irrigation until it has granulated in from the bottom and (2) to close the wound completely either by deep sutures or by a plastic flap in the hope that no dead space will develop as a result of sepsis, tension or formation of hematoma.

### FIRST SERIES: RESULTS

In the series of cases previously reported by one of us [1] treatment was based on these principles. The results are given in table 1. (For the sake of convenience no distinction is made here between true and pseudo-recurrences.) Primary closure by any method gave a rate of recurrence of 36 per cent in twenty-eight cases in which the results of

TABLE 1.—*Results of Radical Excision in the First Series*

| Results | Number of Cases | Percentage of Recurrence |
|---|---|---|
| Primary closure | 28 | 36 |
| Partial closure | 24 | 50 |
| Open packing | 46 | 18 |
| Combined | 98 | 30 |

operation were known; partial closure, a rate of 50 per cent in twenty-four cases, and open packing, a rate of 18 per cent in forty-six cases—the total rate of recurrence was 30 per cent in ninety-eight cases in which information as to the results of operations was obtained.

When the cases in which radical operations had been performed previously were separated from those in which no such operation had been performed the rate of recurrence, as would be expected, was found to be much higher in the first group, amounting to 100 per cent for primary closure, 88 per cent for partial closure and 58 per cent for packed open secondary procedure, as compared with 31 per cent for primary suture, 31 per cent for partial closure and 3 per cent for packed open original procedure or a gross rate of recurrence for secondary procedure, by whatever method, of 76 per cent, as opposed to 19 per cent for original operations.

The average patient in this series lost eight and seven-tenths weeks from work, spent ten and nine-tenths postoperative days in the hospital and made nine and seven-tenths return visits for each radical operation. Among those who were cured, the average time required for the wound

1. Rogers, H.: Pilonidal Sinus, Surg., Gynec. & Obst. **57**:803, 1933.

to heal was two and seven-tenths months. Thirty-nine per cent had residual symptoms referable to the scar. Only 57 per cent of the traced patients rated the result of their operation as excellent or good.

In short, from an analysis of this series and a review of the literature it was clear that the current methods of treating pilonidal sinus were peculiarly unsatisfactory, and a suspicion arose that perhaps the fault lay in a fundamentally wrong conception of the underlying pathologic process. To investigate this possibility it has been necessary to continue to perform radical block excisions in order to secure material for study of the pathologic process. This we have now done in sixty-two additional cases.

## SECOND SERIES: DETAILS OF TREATMENT AND RESULTS

In the study of this second series two objects have been kept in view. One was to learn something about the pathologic process underlying the condition and the other was to find out whether the ill success of treatment was due to faulty technic or was inherent in the methods used.

TABLE 2.—*Results of Radical Excision in the Second Series*

| Results | Number of Cases | Percentage of Recurrence |
|---|---|---|
| Primary closure | 13 | 38 |
| Partial closure | 1 | 100 |
| Open packing | 29 | 25 |
| Combined | 43 | 34 |

Forty-four surgical specimens were studied and will be described presently in some detail. Seventy-two radical operations and one sclerosing procedure were performed.

*Radical Excision* (*Table 2*).—In order to minimize sepsis no radical operation was performed in the presence of acute inflammation. Abscesses were drained and allowed several weeks of treatment in the outpatient department to become quiescent. Before excision at least twenty-four hours were allowed for preoperative cutaneous preparation. Castor oil was given the day before and a cleansing enema the morning of operation to minimize postoperative contamination of the wound. All excisions were performed under general anesthesia to avoid the possibility of spreading infection into sound tissue by the injection of a local anesthetic. With the patient in the prone position the main orifice of the sinus was identified, and all other orifices were closed with sutures or clamps. A sterile solution of methylene blue or a suspension of india ink was forcefully injected into the main orifice. A symmetrical block excision was then performed with a knife, the line of excision was kept outside of all stained tissue, or, if this failed, whatever stained tissue could be seen was removed piecemeal. In each case an ellipse of skin equal in width to the widest extent of the underlying cavity was removed. This was done to insure against the formation of a dead space during healing.

*Primary Closure.*—Primary closure was considered only (1) if the operation was an original procedure, (2) if no gross sepsis or contamination was present,

(3) if satisfactory extirpation of the diseased tissue had been achieved and (4) if hemostasis had been perfect. Depending on the size of the defect to be closed either a midline closure with undercutting at the full depth of the fat or the plastic flap method described by Lahey [2] was then used. Great care was taken to obliterate all dead space and prevent undue tension on stitches by an adequate mobilization of tissues. After the operation the patient was kept in the prone or lateral position for at least eight days. The bowels were kept closed for six days by means of deodorized tincture of opium and a restricted diet. The patient was kept in bed for at least ten days and in the hospital for fourteen days.

A total of six patients with obviously circumscribed lesions had their defects closed by simple undercutting and suture in the midline. In two the lesions failed to heal and further surgical intervention was required for persistent draining sinuses. Two lesions were unhealed at the end of two months and four months, respectively, when the patients were lost sight of. Two healed by first intention.

Twelve primary closures were performed by the plastic flap method. Seven wounds healed by first intention while the patients were in the hospital, but three of these later broke down, one requiring reoperation, and the other two each requiring four months to heal permanently. For four others the subsequent developments were as follows: Two wounds were in patients in whom the results were not traced; one patient complained of numbness and tingling in the wound, rating her result good but not excellent, and the fourth patient is free from symptoms with a result she considers excellent. In four patients septic wounds developed during the period of hospitalization. One is untraced; in one the wound healed in three and one-half months; in one it healed in four months, and the fourth required another operation at the end of six months. In one patient a large hematoma developed during the period of hospitalization and required reoperation at the end of six months.

In thirteen traced cases of primary closures there were five recurrences requiring reoperation, and in only two cases were excellent, in five, good, and in one, fair, results reported, as rated by the patients themselves. Since more than the average amount of care was taken in the selection, surgical treatment and management of these thirteen patients, it seems fair to conclude that the ill success was inherent in the principle of primary closure.

*Partial Closure.*—Only one wound of radical excision was partially closed in this series. Reoperation for persistent draining sinus was necessary ten months later.

*Open Packing.*—All wounds which did not meet the rigid requirements for primary closure were packed wide open with plain or iodized gauze. An attempt was made to have each defect saucer-shaped in order to favor healing from the bottom without dead space. To avoid postoperative contamination the patient was kept in bed, in the prone or lateral position, for four days, during which time the bowels were kept closed. The patient was kept in the hospital for from six to ten days. Thereafter the dressings were cared for by a district nurse daily and by a surgeon of the outpatient department at least once a week until the wound was healed or until a persistent sinus requiring reoperation became established. In this series, as in the previous one, the dressings applied in the outpatient department consisted mostly of repacking the cavity and of touching exuberant granulations with silver nitrate Nothing in the nature of minor surgical intervention was attempted.

---

2. Lahey, F. H.: Surg., Gynec. & Obst. **48**:109, 1929.

Of fifty-two cases of radical excision in which the method of open packing was used, no results are available for twenty-three as either the wounds are too recent for the purposes of this report or the patients are not traced. In the twenty-nine traced patients there were seven recurrences and twenty-two cures, a rate of recurrence of 25 per cent. The economic loss as measured by hospitalization, return visits, etc., was no lower than that mentioned for the previously studied series (table 3).

It will be remembered that for the group in which the open packing method was used in the first series the rate of recurrence was considerably lower than 25 per cent. We believe that this difference can be accounted for by the fact that the patients in the first series were observed for seven years, during which many persistent sinuses had time to heal spontaneously, whereas in the second series the patients with persistent sinuses have been observed for too short a time to ascertain how many sinuses will eventually close. It is important to note that postoperative sinuses are capable of closing spontaneously after having persisted for as long as two years. For example, eight of the patients in the first series were advised by surgeons of the outpatient department that the sinuses required

TABLE 3.—*Comparison of Results and Economic Losses Following Radical Excision in Two Series of Cases*

| Postoperative Data | First Series | Second Series |
|---|---|---|
| Gross rate of recurrence | 30 per cent | 34 per cent |
| Cured patients free from residual symptoms | 61 per cent | 56.3 per cent |
| Result called excellent or good by patients | 57 per cent | 66 per cent |
| Average postoperative period of hospitalization | 10.9 days | 13.4 days |
| Average time to heal | 2.7 months | 3.5 months |
| Average number of return visits | 9.7 | 10.9 |

reoperation as they had failed to heal in respectively four, five, five, five, eleven, twelve, twenty, and twenty-four months after radical excision, but all these patients refused reoperation. Of eight persistent sinuses all but one eventually closed spontaneously. We believe it likely that enough of the persistent sinuses in the second series will also close spontaneously to make the rate of recurrence in the two series about the same.

*Comment on Results of Radical Operation.*—From a comparison of the results so far obtained in our second series with those obtained in our first series, in which a similar method of treatment was used but the cases were not so well controlled (table 3), it is apparent that no great improvement can be expected. By any of the methods which include radical excision in one stage the economic loss is bound to be considerable, and measures designed to lessen the economic loss, such as closure by suture, serve only to increase the danger of failure. The fact that thirty-two of the operations in the second series were performed by one of us and the other forty were performed by resident members of the staff under his supervision satisfies us that the poor results cannot be ascribed wholly, if at all, to faulty operative technic. We are further convinced that the after-care of the wounds treated by radical excision, with the exception of such primary closures

as heal solidly by first intention, is not adequate as carried out at present in the general surgical outpatient department of a large hospital, and we doubt whether it could be made so. We believe that the task assumed by the surgeon who performs a radical excision is only half accomplished while the wound remains unhealed and the patient uncured. The corollary is that the original operator should personally carry out the after-care of each patient. This could be, and is, done in private practice with some degree of success, but we believe that it is not feasible in hospital practice.

From these considerations we conclude that the high rate of recurrence and the considerable economic loss involved in the treatment of pilonidal sinus by the methods described are inherent in those methods.

*Sclerosing Solutions.*—The suggestion has appeared in the literature that radical excision might be avoided by injecting caustic or sclerosing materials in the hope of destroying the epithelial elements of the sinus and hair nest. On theoretical grounds we believe that such a procedure could succeed only in transforming a pilonidal sinus into a persistent scar tissue sinus presenting the same problems as pseudorecurrences following unsuccessful operative measures. In practice alternate injections and curettings are required, with occasional excisions of devitalized skin, so that the procedure assumes the aspect of a radical excision by combined chemical and surgical means.

The one patient in our series treated by this method was subjected to three injections of sclerosing solution, three débridements of slough and four administrations of gas anesthesia over a period of eighteen days in the hospital. He made twenty return visits, and at the end of six months he had a mutilating scar with a persistent draining sinus under it and refused further treatment.

## PATHOLOGIC STUDY

This study was undertaken with the purpose of observing and recording the morphology of the sinus tracts and the associated manifestations of infection, determining the probable cause for the recurrence or persistence of symptoms in the specimens obtained at secondary excisions and evaluating the use of dyes injected preoperatively.

### METHOD OF STUDY

The intact specimen from the operating room was immediately fixed in a dilute solution of formaldehyde, U. S. P. (1:10) for at least twenty-four hours. Parallel longitudinal slices of the entire specimen beginning in the midline were made at intervals of from 2 to 3 mm. Each cut surface was carefully scrutinized under a strong light with a hand lens. Numerous paraffin sections were made from normal-appearing regions as well as from obviously diseased parts.

CLASSIFICATION AND DESCRIPTION OF TRACTS

The tracts were classified as follows:

| | Number |
|---|---|
| 1. Midline tracts | |
| (*a*) With a single opening | 11 |
| (*b*) With two separated openings | 8 |
| (*c*) With multiple openings | 7 |
| (*d*) Dimples | 5 |
| | 31 |
| 2. Tracts extending laterally from the midline | |
| (*a*) With a single midline opening | 1 |
| (*b*) With midline openings and one lateral opening | 5 |
| (*c*) With a midline opening and multiple lateral openings | 1 |
| | 7 |
| 3. Unclassified tracts | |
| (*a*) "Recurrent" | 3 |
| (*b*) Of undetermined structure | 3 |
| | 6 |
| Total | 44 |

1. *Midline Tracts.*—In thirty-one, slightly over 70 per cent, of the specimens, the tracts were confined to the midline with no lateral extensions. The variations in their form are diagrammatically presented in figure 1.

(*a*) Tracts with a Single Opening (figs. 1, *A* 1 and *A* 2): There were eleven of these tracts. All were surprisingly similar, extending inward and upward; they contained sebaceous material, débris and nearly always hair. The variations were in length, depth and degree of infection. The average length was 4 cm.; the actual length ranged from 1 to 7 cm. Only one tract measured 7 cm., and this extended to a point well over the sacrum and ended in an abscess cavity. The depth ranged from a few millimeters below the skin to a few millimeters above the coccygeal fascia. All were infected but, except for the long tract mentioned, not markedly so. The total diameter of involved tissue never exceeded 1.5 cm.

Microscopic sections revealed in most cases a fairly well demarcated zone of acute and chronic inflammatory tissue walled off by dense fibrous tissue. When epithelium was present it usually occurred in clumps of squamous cells, taking no definite form. In a few sections, however, the epithelium was nearly intact, consisting of many layers of squamous cells with cornification and a prominent granular layer. Formation of rete pegs was marked, and hair follicles with an occasional sebaceous gland were located much as they are in normal skin (fig. 4). The caliber of these epitheliated tubes was small as compared to that of the surrounding inflammatory tissue. Two tracts of this group consisted essentially of epithelium-lined cysts full of sebaceous material and coiled hair.

(*b*) Tracts with Two Separated Openings (fig. 1, *B*): Eight of these midline tracts had two discrete openings more than 2.5 cm. apart. In each of these the tract extended directly from one opening to the other.

(*c*) Tracts with Several Openings (fig. 1, *C* 1): Seven midline tracts were of this type. The abnormal tissue in none of these extended more than 1 cm. above the uppermost opening. Grossly a few appeared to consist of several separate

sinus tracts, but microscopic examination showed that they were connected by inflammatory and scar tissue (fig. 1, *C 2*).

(*d*) Dimples: There were five specimens having no actual tract other than an apparently completely epitheliated indentation of the skin in the midline. Sections of these revealed that in all there was some degree of infection in the subcutaneous tissue at the base of the dimple. Beneath one there was considerable scar tissue, suggesting that a fairly extensive infectious process had existed previously. The base of another dimple was within 0.5 cm. of the tip of the coccyx, which was

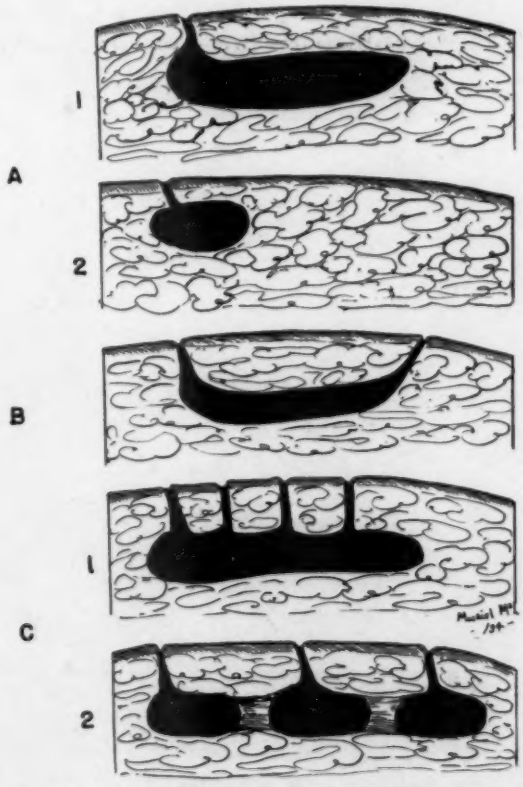


Fig. 1.—The variations of the midline tracts. The diagrams represent longitudinal sections, the upper end being depicted by the part toward the right. *A 1* is a simple tract with single opening; *A 2*, discrete cyst with single opening; *B*, midline tract with two separated openings; *C 1*, midline tract with multiple openings; *C 2*, midline tract with multiple openings appearing grossly to be three separate tracts but seen microscopically to be connected by scar tissue.

removed with it. Microscopic sections showed no suggestion of a fibrous cord or vestige of a communication with neural canal.

2. *Tracts Extending Laterally from the Midline* (fig. 2).—Seven, or approximately 15 per cent, of the tracts were of this type.

(*a*) Tracts with Single Midline Opening (fig. 2, *A*): One tract had a single midline opening and externally was not distinguishable from similar midline tracts.

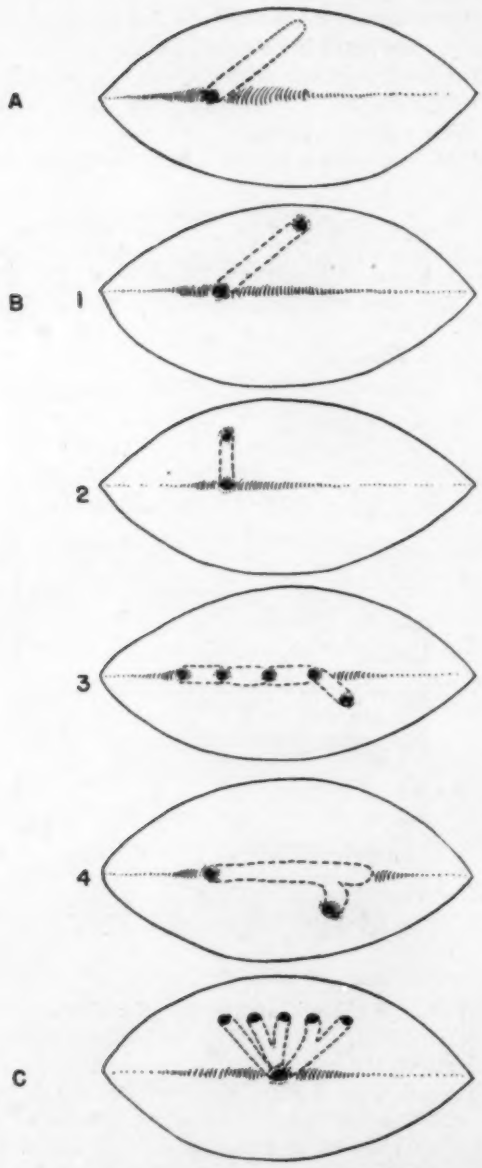


Fig. 2.—The variations of the tracts extending laterally. The diagrams are as viewed from above, the upper end being depicted by the part toward the right. *A* is a tract with single opening extending obliquely; B *1*, oblique tract with lateral opening; *B 2*, lateral tract with lateral opening; *B 3*, midline tract with multiple openings having a lateral extension with opening; *B 4*, midline tract with a single opening having a lateral extension with opening; *C*, tract with single midline opening communicating by ramifications with five lateral openings.

On section, however, it was found to extend obliquely toward the left so that its upper pole was approximately 1 cm. lateral to the midline.

(*b*) Tracts with Midline Openings and One Lateral Opening (fig. 2, *B* 1 and *B* 2): There were five such tracts, three of which extended directly from one opening to the other with no other extensions. The other two were apparently midline tracts with lateral extensions (fig. 2, *B* 3 and *B* 4).

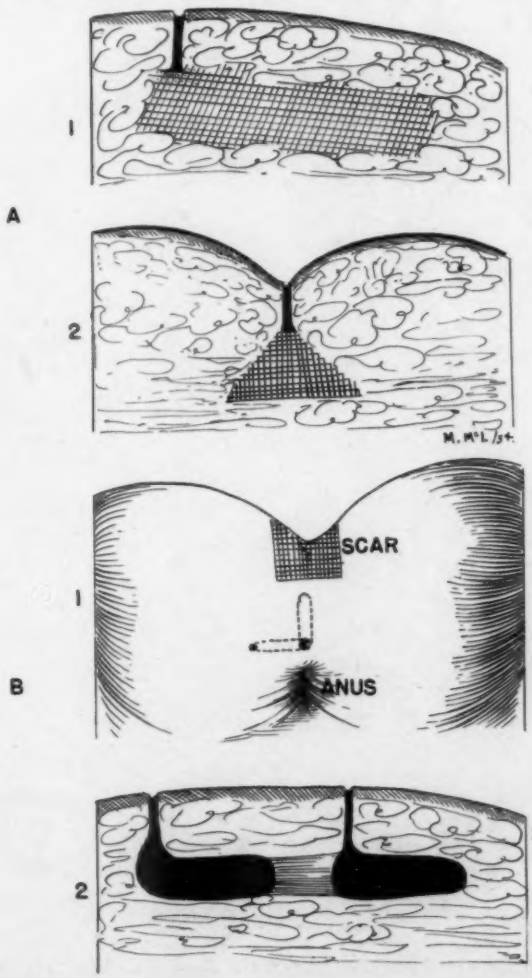


Fig. 3.—The findings in the specimens from secondary resections. *A 1* is a longitudinal section, the cross hatching representing chronic inflammatory tissue; *A 2*, cross-section of same specimen; *B 1*, diagrammatic representation of the anatomic position of the primary operative scar and the portion of the tract which was overlooked; *B 2*, reconstructed longitudinal section of what probably was present, the first resection including only the portion to the right.

(*c*) Tracts with Midline Opening and Multiple Lateral Openings (fig. 2, *C*): One specimen contained a branching tract leading to five lateral openings. In this

case the extensions were all epitheliated and surrounded by marked inflammatory and scar tissue (figs. 5 and 6). No hair follicles could be demonstrated either in these or in the lateral extensions of the tracts in the foregoing group. The skin about the lateral openings was raised and irregular, and its epithelium was bluish.

3. *Unclassified Tracts.*—The tracts in this group numbered six.

(*a*) "Recurrent" Tracts: There were three specimens from secondary excisions. Two of these had single sinus openings situated at the lower end of the

Fig. 4.—Low power photomicrograph of a longitudinal section of a fairly well preserved sinus tract. The upper end is toward the right. *A* is the cutaneous opening of the sinus which follows a tortuous course ending at *B*, where it enters the main tract, *C*; *D*, hair follicles associated with the tract; *E*, a sebaceous gland; *F*, a bit of epithelium apparently isolated by the surrounding chronic inflammatory tissue.

old scar. The epithelium extended deeply, ending in inflammatory tissue in which no epithelium or hairs were found (fig. 3, *A* 1). In both the abnormal tissue on cross-section was roughly triangular (fig. 3, *A* 2), suggesting that it had been

formed by faulty closure or healing—the retention of infected "dead space." The third (fig. 3 *B*) was interesting because it was really not a recurrence but a portion of the tract which was overlooked at the first operation. Two small openings were found considerably below the scar, one in the midline and one lateral to it. There were a central hair-filled and partially epitheliated tract extending upward to a point near the tip of the coccyx and a small lateral extension with no epithelium and surrounded by scar tissue. The primary operation was performed at this

Fig. 5.—Low power photomicrograph of four of the five ramifying tracts depicted in figure 2 *C*. *A* are hair follicles associated with the skin; *B*, epitheliated tracts; *C*, inflammatory tissue. (Note the absence of hair follicles.)

hospital only three months before, and the report on the original specimen is included in this series. The fact that the first specimen contained no epithelium or hair and had but a single opening leads to the belief that possibly this part at one time was continuous with the lower sinus tract, the two portions becoming separated by scar tissue (fig. 3, *B* 2). The error in diagnosis was made probably because the drainage from the upper opening was most marked and the lower openings were distinctly nearer the anus than usual.

(*b*) Tracts of Undetermined Structure: The structure of the tract in these specimens was undetermined. One specimen, which was mutilated by a previous incision and drainage, is included for other reasons and will be referred to in a subsequent paragraph. Another was received piecemeal and is best described by the operative note: "The tract was extensive, extending downward toward the anus and laterally into the gluteal fibers. A hair nest was found measuring 1 cm. in diameter at a point 3 cm. to the left of the midline and partially within

Fig. 6.—High power photomicrograph of a cross-section of one of the tracts shown in figure 5. *A* indicates the lumen; *B*, squamous epithelium; *C*, granular layer; *D*, chronic inflammatory tissue.

the gluteal fibers. The tissue about the anus which was stained with dye was removed." This also will be discussed later.

The third specimen appeared to be a simple dimple, but microscopic examination revealed two discrete clumps of squamous epithelium some distance below the base of the dimple (fig. 7). In multiple sections no suggestion of a lumen or connection with the surface was found. These clumps were surrounded by dense scar

tissue with only slight cellularity. It is possible that this condition represented a sinus tract which had almost completely healed and that the cell clumps were all that was left of the old tract.

## INJECTION OF DYES

Into twenty-four of the specimens an aqueous suspension of india ink (1:40) had been injected before the operation. This suspension was chosen because it

Fig. 7.—Low power photomicrograph of a dimple. *A* shows isolated clumps of squamous epithelium surrounded by comparatively acellular scar tissue; *B*, the location of the orifice of the dimple, not included in the plane of this section; *C*, hair follicle; *D*, epitheliated dimple; *E*, coil gland.

was not dissolved or disseminated by the fixing solutions and could be visualized microscopically as well as grossly. (For specimens into which methylene blue was injected the procedure was altered to omit the primary fixation in formaldehyde. The examination in respect to determining the location of the dye even

then was unsatisfactory, as the color was easily spread.[3]) The injections were made in the usual manner, the surgeon inserting the tip of a 2 cc. syringe into the main opening after accessory openings were closed by suture or with a specially devised clamp. There was no control of the exerted pressure.[3]

The aforementioned specimen which had previously been incised included several bits of ink-stained tissue which were removed from about the rectum. The ink had been injected into what was believed to be a sinus tract, and the operation

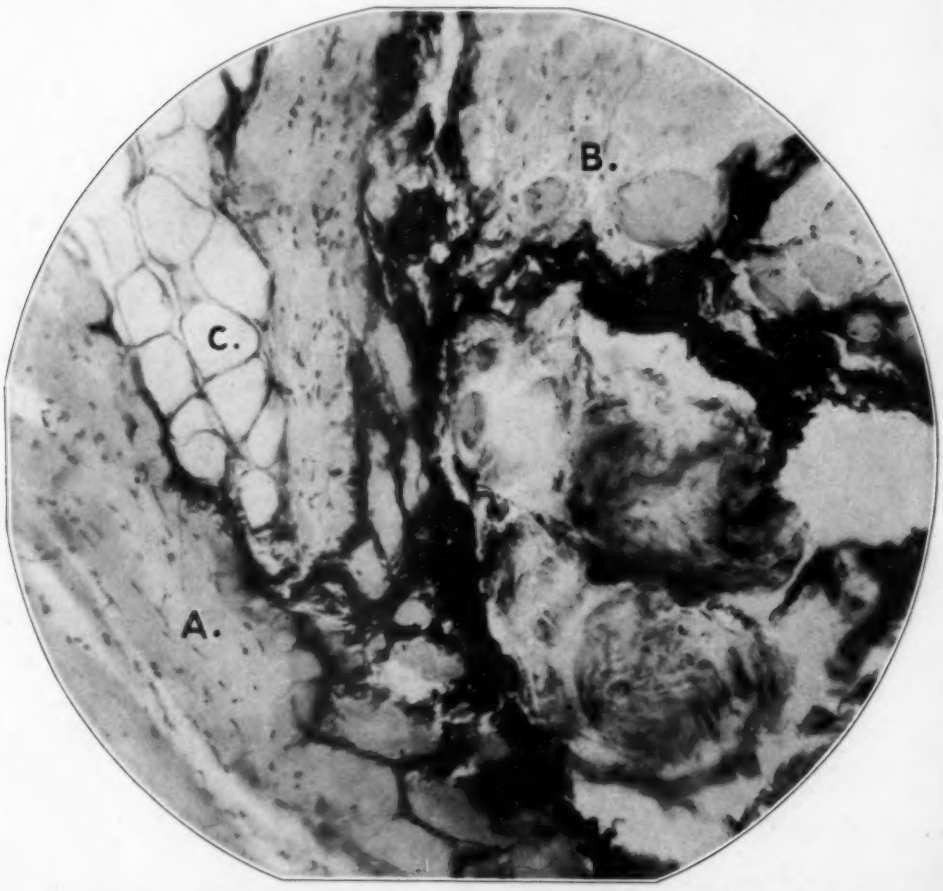


Fig. 8.—High power photomicrograph showing india ink in normal lymphatics. *A* is longitudinally cut muscle; *B*, muscle cut in cross-section; *C*, fat.

became extensive. Microscopic sections of these bits of tissue revealed no evidence of epithelium or inflammatory tissue in the tract, but ink was clearly seen

3. It was originally thought that the ink-filled tracts could be visualized if the surrounding tissue was made transparent by means of a fat-clearing technic. Several specimens were cleared, but it was soon learned that blood vessels filled with changed blood could not be distinguished grossly from tracts containing ink. As several weeks were required to accomplish the clearing and then a supplementary microscopic examination was necessary, this method was abandoned.

in the lymphatics (fig. 8). The statement in the operative note on the other specimen previously mentioned describing the tract as extending downward toward the anus becomes less significant when this possibility is known. Unfortunately, the extra bits of tissue from this specimen which might have been confirmatory if examined were lost in transit to the laboratory.

In three instances the coccyx was removed when the ink stained the coccygeal fascia. Sections, however, failed to show evidence of pathologic changes within the fascia or the bone. In other specimens ink had penetrated normal tissue for

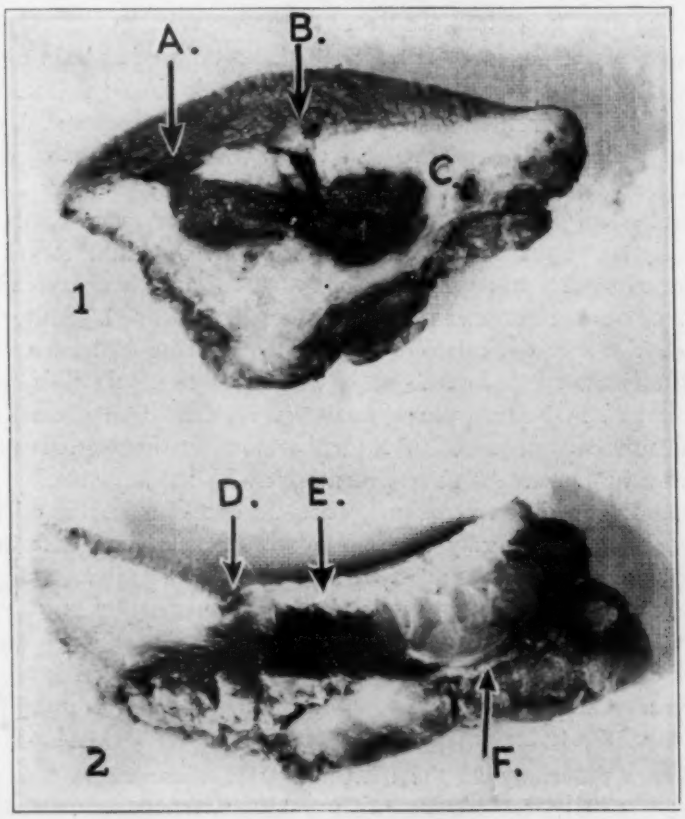


Fig. 9.—Photograph of two specimens after injection of india ink. (The upper end is at the right side.) In *1* is seen a midline tract well filled with ink. *A* indicates the main opening; *B*, an accessory opening; *C*, dense scar tissue. The second specimen, *2*, shows a dimple with underlying infection into which the ink has been injected too forcefully. *D* indicates the orifice of the dimple; *E*, finger-like projections toward the skin; *F*, the line of cleavage. (Note that the ink-stained area in this specimen is surrounded by normal fat.)

small distances about the sinus tracts, and in some the ink only partially filled the tracts themselves.

Figure 9 shows two specimens into which ink was injected; one represents a successfully filled midline tract; the other, a dimple with underlying infection in which the injection was made too forcefully. This error supplies a significant

picture. The ink has penetrated for the most part upward and roughly takes the form of a true sinus tract. The finger-like projections toward the skin suggest the mode of formation of the secondary openings in infected tracts. The line of cleavage running upward, so obviously shown in this specimen, was not apparent in the other specimens of dimples.

### COMMENT ON PATHOLOGIC CHANGES

This study discloses several points of interest to the surgeon.

1. The most important are the observations relating to the preoperative injection of dyes into the tracts. This procedure has been used with varying favor for many years, and although it is not believed to be a perfect guide for the surgeon it has been considered of value. The study of the specimens of this series into which injections of dye had been made suggests that the use of dyes is dangerous if not definitely contraindicated. When a suspension of india ink was used it was frequently found that the particles of ink were forced into normal tissue, leading to much more extensive operations than necessary, and that the actual sinus tract was not always completely filled. Although the study of the specimens into which methylene blue had been injected was unsatisfactory, it is reasonable to believe that this fluid, being a true solution, may penetrate normal tissue to an even greater extent than does the suspension of ink. Furthermore, methylene blue not only fills spaces but colors the tissues themselves. When any coloring matter is present the operation necessarily becomes one of removing all stained tissue, for it is practically impossible grossly to differentiate between normal and abnormal tissue when both are stained alike. Only when the entire tract and nothing else is filled can the injection of stain be of value, and there seems to be no way of bringing this about. The controlling of the pressure by which the dye is introduced is of no aid as no preoperative determination of the thickness and permeability of the walls of the tracts is possible.

2. From the study of the morphology of these tracts it is found that the majority are simple midline tubular structures. The great majority of specimens examined included large portions of normal tissue unnecessarily removed. No rule can be made as to the size of the dissection which will remove only pathologic tissue, but it is interesting to note that for midline tracts a block not exceeding 2 cm. in width would have been sufficient. The length as determined by the number of openings would have been adequate had the dissections started at a point 1 cm. below the lower opening and extended to a point 5 cm. above single openings and not over 1 cm. above the uppermost of multiple openings. The one specimen which had a tract reaching 7 cm. above a single opening was easily recognized clinically. When lateral openings were present, incisions not more than 0.5 cm. outside them

would have removed all diseased tissue. The one tract which extended obliquely from a single central opening might have been partially retained had the block been only 2 cm. in width.

None of the tracts in this series extended beneath the coccygeal fascia, but it is realized that the occurrence of some structures which have communicated with the neural canal have been reported.[4] These were situated over the sacrum or low lumbar region, higher than the usual site of a pilonidal sinus. Because of this the identification of such structures with the ordinary pilonidal sinus may be disputed.

3. Infection plays an important part in all these specimens. There is evidence of its presence even beneath the simple dimples. It seems probable that the lateral extensions are all formed by infection which is blocked from its natural escape and burrows along the lines of least resistance. The accessory openings, by appearance as well as by their clinical history, have been formed by the rupture of infected tissue from below. The persistent granulating inflammatory sinus becomes epitheliated perhaps from both ends. (The histologic picture of these extensions differs in no way from that of the epitheliated sinus tracts present in other chronic infections, such as osteomyelitis.) In a recently formed sinus or in one which was recently the site of a destructive inflammatory process no epithelial lining is found.

In general, it is probable that before any abscess forms the pilonidal sinus is a simple tract with never more than one or two closely associated sinus openings.

4. The study of the specimens from the secondary resections suggests that the recurrence or persistence of symptoms is probably due to the retention of infected tissue or to faulty healing which causes the formation of an infected dead space. The impression that "recurrence" is always caused by the growth of the retained tract or its accompanying structures, the hair follicles and sebaceous glands, is not substantiated. We were unable to demonstrate that epithelial elements left behind at a previous excision undergo any changes except those incident to infection.

From this study it seems most logical to make the dissection as small as possible in order to insure good healing and to rely on the surgeon's ability to recognize diseased tissue in a field which is not obscured by excessive blood or by dyes.

## SURGICAL APPLICATION

If our observations are correct, we may consider that we are dealing with a simple, rather circumscribed, structure. Persistence of a draining

4. Ripley, W., and Thompson, D. C.: Pilonidal Sinus as the Route of Infection in a Case of Staphylococcus Meningitis, Am. J. Dis. Child. **36**:785 (Oct.) 1928. Moise, T. S.: Surg., Gynec. & Obst. **42**:394, 1926.

sinus after any method of treatment is due to the presence of chronic infection, in epithelial elements or in other tissue, either present from the start or developing subsequently but always in such a location as to prevent the sound healing of the wound.

Any attempt to conform to this concept and at the same time to reduce the economic loss to a reasonable minimum involves first of all getting away from the idea that cure depends on a successful radical excision. Cure does depend on the eventual removal of all diseased tissue, both that which is present at the time of operation and that which may appear in the wound during the process of healing. If this is true, it follows that the care of the wound is of at least equal importance with the operation itself.

In a bloodless field, where no dye is present to invade lymphatics or stain normal tissues, it is usually easy to recognize diseased tissue by its appearance and consistency. It is always easy to recognize it by its behavior in a healing wound. Thus the surest way of eliminating the epithelial elements and accompanying or subsequently developing inflammatory tissue would be by a series of minor surgical procedures extending over the entire time it takes for the wound to heal.

Such a program can be carried out only if the patient is ambulatory and unhospitalized. The method implies the use of local rather than general anesthesia, but the anesthetizing substances must be administered in such a way as to avoid the danger of disseminating infection. It also implies that the entire management of each case should be in the hands, or under the supervision, of the surgeon who undertakes to effect a cure.

### TREATMENT OF AMBULATORY PATIENTS BY EXCISION WITH THE CAUTERY

A method of treatment in accord with our present concept of the disease is now being used at the Massachusetts General Hospital and was described in 1932 by F. D. Stanton of the Dover Street Clinic.[5] The operation is performed under local infiltration anesthesia, but only the skin along the midline is anesthetized so that there is no disseminating of infection into sound tissues (fig. 10). The cutting is done entirely with a cautery knife;[6] this method provides a bloodless field which facilitates the recognition of unstained diseased tissue, not only by its appearance but by the fact that such tissue is less readily divided by the cautery knife than is normal fat. The diseased tissue is first completely divided longitudinally down to the sacrococcygeal fascia and is then removed in halves by slightly undercutting the edges of the skin (fig. 11). The resultant narrow cavity is packed, and the

5. Stanton, F. D.: Tr. Am. Coll. Proct. **9**:69, 1932.

6. A Post cautery point no. A 4 at maximum heat is used.

patient is allowed to go home. This procedure has proved to be a minor operation producing no systemic reaction. Not only is hospitalization avoided, but the patient remains ambulatory throughout, and the total time lost from work may be as little as half a day.

At first glance it appears that dead space must result from the failure to remove any skin. This would undoubtedly be the case were it not for the careful application of postoperative dressings which rivals in importance the operation itself. Each time the wound is dressed the floor of the cavity is scrutinized, and any unhealthy-looking area of

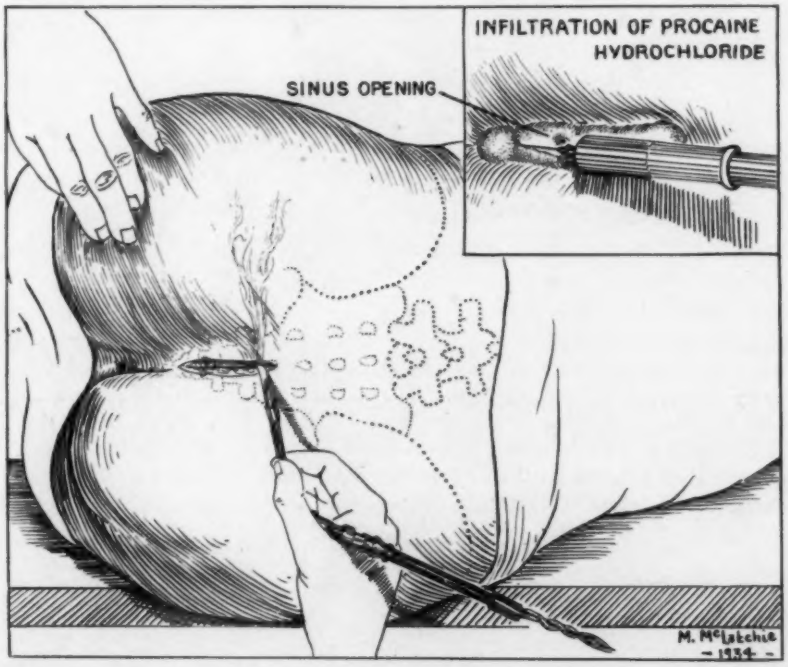


Fig. 10.—Cautery excision of a pilonidal sinus. The left buttock is retracted by an assistant. The cutaneous incision must be made rapidly to avoid charring.

granulation tissue is painlessly curretted down to a solid base or excised with the cautery knife. By this method of fractional operation whatever diseased tissue may have been overlooked at operation is recognized and removed during the period of healing. The cavity is kept packed until it has been obliterated by the growth of healthy, solid granulation tissue, which then appears as a narrow coxcomb between the two edges of skin. It is important to keep this coxcomb down to the level of the surrounding skin until the whole surface has become epitheliated. The end-result is a linear midline scar.

Sometimes the last inch shows a disinclination to heal or heals and splits repeatedly before becoming completely epitheliated. This may be corrected by making an incision through the normal skin parallel to and 2 cm. away from the offending area, thus relieving the lateral tension on the scar. Both wounds will then heal rapidly and satisfactorily.

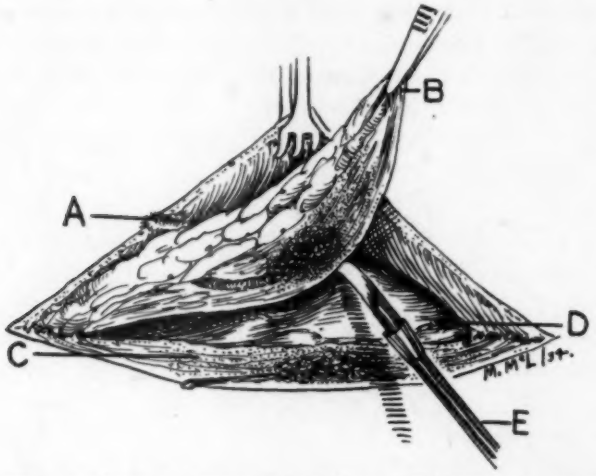


Fig. 11.—The specimen is removed in halves. Bleeders are stopped immediately by a touch of the cautery point. The fascia is sensitive and if approached too closely requires infiltration of procaine hydrochloride. This sketch shows the skin undercut farther than is usually necessary to get around the diseased tissue. *A* shows the sinus; *B*, the left half of the specimen being removed; *C*, the right half of the specimen before removal; *D*, the sacrococcygeal fascia; *E*, the cautery knife.

Fig. 12.—*A* is a cavity formed by radical excision with a knife; *B*, cavity formed by conservative excision with the cautery. Cavity *B* fills more rapidly than does cavity *A* because it offers a more extensive base for the growth of granulation tissue.

The healing of the cavity left by conservative excision with the cautery is more rapid than that left by radical excision with a knife, partly because less tissue has been removed and partly because of the more favorable shape of the cavity (fig. 12). It is apparent from the diagram that *B* would fill in more rapidly than *A*, even were they of

the same capacity, owing to the more extensive base offered for the growth of granulation tissue.

The fact of the patient's being ambulatory introduces three theoretical difficulties, all of which are in practice easily controlled: 1. Postoperative oozing may be effectively prevented by moistening the original gauze pack with a hemostatic solution, such as thromboplastin. 2. Postoperative pain, though it is slight, may be still further reduced by applying to the edges of the incised skin one of the analgesic preparations such as butesin. 3. Saprophytic infection, so commonly seen in the large granulating wounds resulting from radical excision, may be minimized by keeping the gauze packing saturated with a nonirritant antiseptic solution, such as metaphen or mercurochrome.

After the first return visit on the third or fourth day it may not be necessary to treat the wound oftener than once in four or five days, but the patient must be convinced that these dressings are a more important part of the treatment than the operation itself.

The dressings are best carried out, as is the operation, with the patient lying on his right side with the knees drawn up, the left buttock retracted by an assistant and the operator sitting down with the necessary materials within reach (fig. 10). If the operation has been performed in the outpatient department, it follows that the postoperative management will be under the direct supervision of the original operator. We consider this essential to the complete success of the method.

We believe that by this method persistent draining sinuses can be entirely prevented and that once the wound is healed, true recurrence will never take place. A true recurrence is theoretically possible only by assuming that a retained epithelial element would not prevent the healing of the wound and that at a later date it would become infected and initiate a repetition of the original onset. Our observations lead us to believe that no such assumption can be made. Sufficient time has not yet elapsed, however, to enable us to say, on the basis of the lesions already treated by this method at the Massachusetts General Hospital, whether such an occurrence is a practical possibility or not.

### THIRD SERIES: RESULTS OF CAUTERY EXCISION

Fifty cautery excisions have been performed during the past eight months at the Massachusetts General Hospital, approximately the same ratio of secondary recurrent cases and new cases prevailing as in the former series. Twenty-nine of the fifty wounds are known to be completely and satisfactorily healed. In the remaining cases either the wounds are too recent to be healed or the patients have returned to their local physicians for dressings so that we do not know the present status of the wound. There are no known failures or recurrences as yet.

There were several instances of delayed healing about which more will be said presently. Of the twenty-nine healed wounds, twenty-four healed in an average period of nine weeks; the shortest period of healing was between five and six weeks. The general average for the time of healing is raised to two and seven-tenths months, however, by five cases of delayed healing (table 4).

The average postoperative stay in the hospital was less than one day. Sixteen patients were operated on in the outpatient department, and of the thirty-four who were operated on in the hospital, almost all went home on the same or on the following day. The majority of these thirty-four patients were admitted to the hospital from habit, since up to eight months ago all the patients with pilonidal sinus had been hospitalized. Seven operations, however, were performed in the hospital advisedly, since the extensive scarring present offered too great an obstacle to the successful use of local anesthesia. General anesthesia was therefore used in seven instances. In the other forty-three cases local anesthesia proved perfectly satisfactory.

TABLE 4.—*Results of Cautery Excision in the Third Series (Fifty Cases)*

| | |
|---|---|
| Gross rate of recurrence | 0 (to date) |
| Average postoperative hospitalization | 1 day or less |
| Average time lost from work | 1 week |
| Average time to heal (29 cases) | 2.7 months |

The loss of time from work varied from none up to two weeks. The majority of patients stated that the maximum discomfort occurred during the third or fourth postoperative day, but in no case was it sufficient to prevent a visit to the outpatient department. It was not unusual for the patient to attend a ball-game or a dance on the day of operation. There has been no instance of acute infection following operation, in spite of the fact that one excision was performed in the presence of an acute abscess.

Several of the practical points gained through our experience with the cautery method may be worth mentioning without comment. In dividing tissue with the cautery, ease of cutting is directly proportional to the tension exerted on the tissue. Pressure on the cautery blade should never be necessary. One excision was performed with the electrosurgical diathermy unit, but hemostasis was much inferior to that produced by the cautery. Bleeders should be controlled as soon as encountered to ensure a really bloodless field. The cutting should be deliberate to get the best hemostatic effect, except during the maneuver of undercutting the edges of the skin, which must be rapidly done to avoid a slough. The natural tendency to follow along the surface of the coccyx down to its tip must be resisted, except when the presence

of diseased tissue makes it necessary, as the resultant deep hole is slow to heal. An incision connecting the posterior portion of the perineum with the gluteal cleft greatly complicates healing and usually results in an irregular scar. For this reason a two-stage procedure should be considered in cases of extensive involvement with openings near the anus and over the sacrum. The excision of an acute abscess is unsatisfactory because of hyperemia and friability of the tissues. The result in our one case, however, was good.

As for the postoperative care, it may be considered to fall into two stages, divided by the disappearance of all slough from the wound. During the period of slough dressings may need to be changed every two days to prevent odor. Any attempt to remove the original packing before the fourth postoperative day, however, causes pain and bleeding and should not be made. Until all slough has disappeared there is no object in looking for areas of defective healing, as they show up only in contrast to clean, healthy granulation tissue. Undercut edges of skin if allowed to stick down will delay healing and form a poor scar.

Once the slough has separated, the wound should fill rapidly with healthy granulation tissue and close to a narrow linear scar, the total time from the operation to the formation of the scar being six weeks or less. As already intimated, in several of our cases healing was delayed far beyond this schedule. This might be anticipated in the case of unusually large or ill cared for wounds. The puzzling thing is that some of the wounds which apparently had everything in their favor took the longest time to heal. The delay was not due to defective healing in definite circumscribed areas of the wound, since such areas were always removed on sight, but the whole wound, after progressing to a certain point, seemed to have lost all stimulus to further healing, so that weeks passed with no appreciable progress being made beyond that point. Coincident with this abrupt cessation of healing there was usually extreme sensitiveness in a wound which had not exhibited that symptom before. Often, but not always, the granulation tissue appeared pale and smooth when before it had been red and granular. Sometimes there was actual regression, as if the tissue had been destroyed by a cytolytic ferment.

### DELAYED HEALING

It is our purpose here not to write a monograph on the factors influencing healing in a granulating wound but only to suggest the need for such a monograph. Several hypotheses are suggested by analogous phenomena observed elsewhere. In phagedenic ulcers, for example, actual destruction of tissue is brought about by toxins or ferments formed by the symbiotic organisms in the wound. This

action can often be stopped by the oxygen liberated from such a substance as zinc peroxide, because it kills the bacteria, restores the vitality of the tissue cells or does both. It is possible that the delayed healing of certain pilonidal sinus wounds is due partly to bacterial action and partly to reduction of blood supply by contraction of the original deep layers of granulation tissue as their fibroblasts mature to connective tissue cells. It is certain that all these wounds are constantly contaminated from their proximity to the anus, so that such a hypothesis is not at all far-fetched. At present we are experimenting with various bactericidal and oxygenating substances in an attempt to shorten the period of healing and discover and avoid whatever mechanism is responsible for these peculiar cases of delayed healing.

In conclusion, we believe the successful treatment of pilonidal sinus to be primarily a problem of wound healing, the exact method by which the abnormal tissue is recognized and removed or destroyed being of slight relative importance. While the method described is an improvement over older methods, particularly in respect to lessening economic loss and recurrence of symptoms, there is still room for great improvement through a better understanding of the factors influencing the healing of granulating wounds.

## SUMMARY AND CONCLUSIONS

The results of treatment in a series of one hundred and eighty-one cases of pilonidal sinus have been analyzed.

A study of the pathologic changes in forty-four surgical specimens of pilonidal sinus has been made.

The economic loss incident to any method of treatment based on radical excision, even under ideal conditions, is greater than the importance of the disease warrants.

On morphologic grounds there are no indications for radical excision.

In a bloodless field unstained by dye diseased tissue is recognizable by its appearance and consistency.

During wound healing diseased tissue is distinguishable from healthy tissue by its lack of normal growth.

A method of treatment by repeated excisions with the cautery of diseased tissue only, carried out as minor operations on ambulatory patients, is described and recommended.

A preliminary report on the treatment of fifty lesions by excision with the cautery is made.

# PATHOLOGIC CHANGES OF DISEASED GALLBLADDERS

## A NEW CLASSIFICATION

EDMUND ANDREWS, M.D.
CHICAGO

Very early in our studies on the gallbladder it became clear to my associates and me that the present systems of classification of cholecystitis were at fault. As the work progressed it became with increasing frequency impossible to correlate the pathologic changes with either the clinical, bacteriologic or the postoperative course. As increasing numbers of cases became available for study, these discordances were so glaringly evident that it was clear that our methods of pathologic classification were inadequate (figs. 1 and 2). For these reasons the various conditions were entirely reclassified de novo, as will be elucidated in the comment.

### MATERIAL AND METHOD

The material studied consisted of a series of fifty-four specimens which were removed at operation in cases in which elaborate chemical and pathologic studies as well as chemical studies had been made, as reported in a recent paper.[1] In sixty-one other cases, chemical, bacteriologic and clinical studies were made, but no sections cut at intervals of 2 cm. were studied. In many cases a technic of excision was carried out in which the gallbladder underwent a minimum operative manipulation. A clamp was placed on the fundus, and whenever possible, by making traction on the gallbladder itself, the cystic duct was exposed without handling the main body of the viscus. The duct was clamped, and the gallbladder was removed in a retrograde manner, being touched only by the clamp at each end. Of course this ideal was not always achieved, but practice enabled us to carry it out in a sufficient number of cases to warrant drawing very definite conclusions as to how much of the previously reported pathologic change in the gallbladder was really due to mechanical injury.

Cultures were made of both the bile and the wall of the gallbladder, and the gallbladder was then emptied and the interior inspected, following which a solution of formaldehyde was injected into it so that it was distended. After a certain amount of hardening had taken place the gallbladder was immersed in a solution of formaldehyde for complete fixation. The specimen was then divided into a series of rings about 2 cm. wide. These rings were embedded in paraffin (the larger ones in pyroxylin) and sections were cut and stained with hematoxylin and eosin. A study of these serial sections was made, the pathologic changes encountered in each of the various layers of the wall being noted on a special form, and the changes, together with the clinical and bacteriologic data, were recorded in the tables.

---

From the Department of Surgery, the University of Chicago.

1. Andrews, E.: Detailed Studies of a Series of Gall-Bladder Cases, Surg., Gynec. & Obst. **57**:36, 1933.

In view of the previously mentioned failure to correlate the clinical signs and the pathologic changes, a grouping was made on a very broad basis; i. e., one group contained gallbladders showing signs of clinical activity, either active or very recent, and the other group contained those that were removed between attacks when the patients were not acutely ill. A small group of gallbladders which proved to be normal, removed for various reasons, was included in a third group.

It will be seen from examination of table 1 that we have been rather radical in attacking the recently inflamed gallbladder. In only one case of the entire series was operation performed because of fear

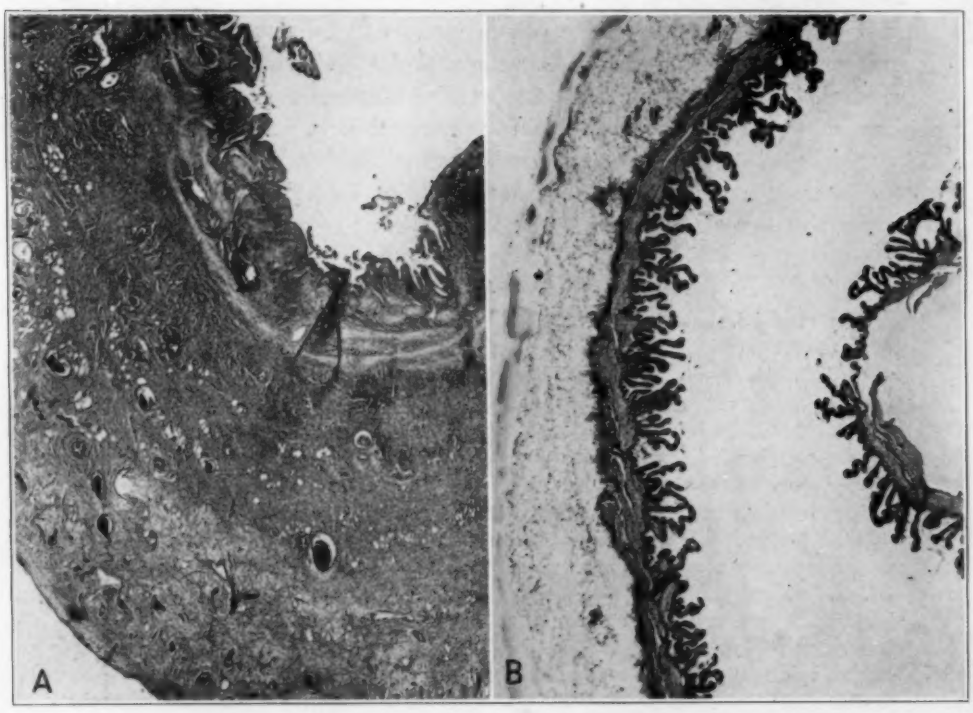


Fig. 1.—Photomicrographs illustrate the lack of correlation between the clinical signs and the histologic picture in cases of disease of the gallbladder. *A* is a section from the gallbladder of a 34 year old woman who presented no symptoms at the time of operation or for two weeks before. She previously had had many severe attacks of colic. The last attack was afebrile, and the white blood count did not exceed 8,000. A stone was found in the cystic duct. Grossly, the gallbladder was markedly thickened and hard to the touch. Histologically, a very severe degree of cholecystitis was present. Reduced from a magnification × 23. *B* is a section from the gallbladder of a patient who had many severe attacks of colic for twenty years. They occurred almost daily for one month. Slight jaundice was present in the last attack nine days before operation. The area was still very tender at the time of operation. The patient was cured by cholecystectomy, according to follow-up reports. Grossly, the gallbladder was normal, and histologic examination also showed a practically normal gallbladder.

of rupture. All the other gallbladders were deliberately excised rather promptly after the subsidence of the acute attack. This had been justified in our own experience by various findings, which will be discussed later, and also by the recent occurrence in the literature of a considerable group of papers calling attention to the fact that it was safe to operate on many acutely inflamed gallbladders.[2] Our own operative experience has amply confirmed this. There were no deaths in the group of acute cases of disease of the gallbladder, and the postoperative morbidity was but slightly greater than in the group of chronic cases. In fact, it is quite curious that the worst postoperative results and the only postoperative death were in the group in which the gallbladders were normal. While it must be freely confessed that the technical difficulties of surgical intervention in cases of recent attacks are considerably greater, it appears from our operative results that the difficulties are harder only for the surgeon and not for the patient. Most striking of all is the fact, which can be elicited from a study of tables 1 and 2, that the microscopic appearance in the so-called cases of acute or recent disease of the gallbladder showed little more extensive pathologic change than in the group in which operation was performed during quiescent intervals.

## BACTERIOLOGIC OBSERVATIONS

Most of the previous studies on the bacteriology of cholecystitis were made by technics which today do not seem adequate. Recent demonstrations of the rich bacterial flora of the normal liver [3] and gallbladder [1] make it quite clear that to be of any real significance the studies must not simply demonstrate the presence or absence of bacteria but must be quantitative. Since it has been shown that many pathogenic bacteria are normally present, in order for the result to be of clinical importance an increase in the normal flora must be demonstrated. On the other hand, simple swabs may often lead to negative results in cases in which culture of a larger amount of tissue or bile shows many microorganisms.

These bacteriologic studies are being reported in full in another paper,[4] but on account of their relation to the pathologic and clinical

2. Miller, R. H.: Acute Cholecystitis, Ann. Surg. **92**:644, 1930. Judd, E. S., and Phillips, J. R.: Acute Cholecystic Disease, ibid. **98**:771, 1933. Lahey, F. H.: Acute and Subacute Cholecystitis, S. Clin. North America **13**:595, 1933. Stone, H. B., and Owings, J. C.: The Acute Gall-Bladder as a Surgical Emergency, Ann. Surg. **98**:760, 1933.

3. Ellis, J. C., and Dragstedt, L. R.: Liver Autolysis in Vivo, Arch. Surg. **20**:8 (Jan.) 1930. Andrews, E., and Hrdina, L.: Cause of Death in Liver Autolysis, Surg., Gynec. & Obst. **52**:61, 1931. Andrews, E.; Rewbridge, A. G., and Hrdina, L.: Causation of B. Welchii Infections in Dogs by Injection of Sterile Liver Extracts or Bile Salts, ibid. **53**:176, 1931.

4. Andrews, E., and Henry, L. D.: The Bacteriology of Normal and Diseased Gall-Bladder, Ann. Surg., to be published.

TABLE 1.—*Tabulation of Detailed Findings*

| Name | History | Last Attack; Time Before Operation | Roentgen Examination | Gross Appearance of Gallbladder | Stones | White Blood Cells in Bile | Cultures | | Postoperative Course | Microscopic picture | | Mucosa | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Wall of Gallbladder | Bile | | Asymmetry | Rokitansky-Aschoff Sinuses | Ulcer | Cellular Infiltration | Polymorphonuclears | Lymphocytes |
| Church | Nausea; vomiting; jaundice | 1 day† | N.V. | Thick; mild acute infection | Yes | 0 | S. | S. | Stormy, subdiaphragmatic abscess | No | None | Cholesterosis | | | |
| Deutsch | Many attacks of colic | 2 days | N.V. | Not thick; hour-glass adhesions | Yes | ..... | S. | S. | Smooth | No | None | Cholesterosis | | | |
| Essig | Severe attacks for 18 months; fever | 5 days | N.V. | Normal | Yes, in common duct | 1,260 | Strep. viridans | | Rather stormy | No | None | Cholesterosis | | | |
| Fassal | Deep painless jaundice and acute attacks of colic | Recent | Not made | Dilated; normal | No | ..... | 0 | B. welchii; B. coli | ..... | ... | ... | ... | ... | ... | ... |
| Gilmore | Dyspepsia; many attacks of biliary colic for 3 years | 6 days | N.V. | Large; thick | Yes | 2,500 | B. coli | B. coli | Uneventful | No | None | ... | ... | ... | ... |
| Lathrope | Typical attacks of colic for 7 mos.; some with jaundice | 5 days | N.V. | Small; thick | Yes, paste | ..... | Bacteria | S. | Uneventful | | | | | | |
| Nelson | Many acute attacks | 9 days | N.V. | Very thick; tense | Yes | ..... | S. | S. | Uneventful | No | None | 3+ | 4+ | 2+ | ... |
| Radley | Many attacks of colic; jaundice lately | Few days | Slight | Tense | Yes | 750 | Strep. | Strep. | Uneventful | Yes | None | ... | ... | ... | ... |
| Springer | Many typical attacks of colic | Few days | Not done | Large | Yes | ..... | Staph.; B. welchii | Staph.; B. welchii | Smooth | All layers blended. | | | | Extreme | |
| Vazmus | Repeated attacks of colic; chills and fever; belching of gas | 5 days | N.V. | Thick subacute inflammation | Yes | 2,400 | B. welchii; B. coli | B. welchii; B. coli | Fever | ... | ... | ... | ... | ... | ... |
| Bache | Several attacks of biliary colic, last with jaundice | 5 days | N.V. | Small; thick | Yes | ..... | Staph. | Staph. | Not smooth | Yes | 1+ | ... | ... | ... | ... |
| Baumgartner | Three attacks of biliary colic in last year; no jaundice | Recent | N.V. | Thick; white; packed with stones | Yes | 3,124 | Staph. | S. | Uneventful | ... | ... | 0 | 0 | ... | ... |
| Burke | Numerous attacks of biliary colic for 4 years | 3 days | V. | Few adhesions, not very thick | Yes | 4,262 | B. diphtheriae | S. | Uneventful | ... | ... | ... | ... | ... | ... |
| Campbell | Many attacks in 1 year; deep jaundice | 4 days | V. | Enlarged; thick; white | Yes | 550 | Staph. | S | Uneventful | ... | ... | ... | ... | ... | ... |
| Ceresa | Entered hospital during very acute attack | 3 days | Not done | Very thick | Yes | 6,800 | B. coli | B. coli | Smooth | .. | ... | ... | 1+ | 1+ | 1+ |
| Crabbe | Entered hospital in first acute attack | 5 days | N.V. | Subacutely inflamed | Yes | 1,150 | B. typhosus | S. | Ileus | ... | ... | ... | 1+ | ... | ... |
| Dobrolecki | One attack 1 year before; another attack of jaundice | 2 days before | N.V. | Shrunken; thick | Yes | 4,250 | Staph. and B. diphtheriae; B. alkaligenes | | Smooth | ... | ... | ... | Sl. | ... | ... |
| Dorn | Many attacks of biliary colic for many years; dyspepsia | Recent | V. | Dense; adhesions to duodenum | Yes | 1,250 | S. | S. | Uneventful | ... | Few | ... | ... | ... | ... |
| Drechsel | Many attacks for 32 years | Recent | Faint | Large; thick; injected | Yes | 3,460 | S. | S. | Uneventful | ... | 2+ | ... | ... | ... | ... |
| Hatfield | Many acute mild attacks recently | Recent but mild | Faint | Thin; no inflammation | Yes | 2,346 | B. diphtheria | .. | Uneventful | ... | 1+ | ... | ... | ... | ... |
| Jenkins | Entered hospital with acute abdominal condition; large liver; no jaundice | 5 days | Not done | Very thick; tense | Yes | 1,250 | S. | S. | Uneventful | ... | ... | Fibrous, actually | | | |
| Kennedy | Many attacks in last 5 months | 1 day | Not done | Tense; thick | Yes | 4,400 | S. | S. | Stormy | 2+ | 2+ | ... | Sl. | ... | ... |
| Mathews | Typical attacks for 20 years; jaundice for 9 days | 9 days | Not done | Distended; adhesions | No | 2,132 | Staph. | S. | Uneventful | ... | ... | ... | ... | ... | ... |
| Owen | Attacks of biliary colic for 10 years; getting worse | Recent | N.V. | Very thick; large | Yes | 2,176 | B. coli | B. coli | Uneventful | ... | ... | ... | ... | ... | ... |
| Patterson | Constant pain in right upper quadrant for 8 months | Recent | N.V. | Distended; thick | Yes | 3,240 | S. | S. | Uneventful | ... | ... | ... | ... | ... | ... |
| Woodward | Admitted to hospital in subacute attack of 12 days' duration | Active | Not done | Enormous; dilated | Yes | 1,026 | S. | Staph. albus | Uneventful | 1+ | 4+ | Distal portion 4+ | ... | 3+ | 3+ |
| | | | | | | | | | | | 1+ | Proximal portion ... | ... | ... | ... |

* In this and in the other tables, N.V. means not visualized; V, visualized; S., under cultures, sterile; Sl., slight; D., diffuse; Pv., perivascular, and F., focal. The degree of infiltration is graded 1, 2, 3 or 4 plus.

† This patient also had an attack four years before operation.

*in "Acute" Cases of Cholecystitis**

| | | Submucosa | | | | | | | | Muscularis | | | | | | | | Serosa | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Eosinophils | Distribution | Follicles | Edema | Fibrosis | Cellular Infiltration | Polymorphonuclears | Lymphocytes | Eosinophils | Distribution | Hypertrophy | Edema | Fibrosis | Cellular Infiltration | Polymorphonuclears | Lymphocytes | Eosinophils | Distribution | Edema | Fibrosis | Thickening | Cellular Infiltration | Polymorphonuclears | Lymphocytes | Eosinophils | Distribution | Comment |
| | | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | Few | ... | D. | 2+ | 1+ | 2+ | 1+ | ... | 1+ | ... | D. and F. | |
| | | ... | ... | ... | ... | ... | ... | ... | ... | ... | 1+ | ... | ... | ... | ... | 1+ | ... | 1+ | 1+ | ... | ... | ... | ... | 1+ | D. | Accessory duct ? |
| | | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | Histologically normal gallbladder |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | Had cancer of pancreas |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 2+ | 4+ | ... | 1+ | ... | 1+ | ... | D. | 4+ | ... | ... | ... | ... | ... | ... | ... | Dehydrated edematous gallbladder |
| ... | ... | Sections near cystic duct normal; near wall of fundus resembles abscess cavity | | | | | | | | | | | | | | | | | | | | | | | | |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 2+ | ... | ... | Sl. | ... | 1+ | ... | D. | ... | ... | ... | ... | ... | ... | ... | ... | Normal gallbladder |
| fibrosis. | | Focal and perivascular infiltration by lymphocytes | | | | | | | | ... | 4+ | | | | | | | | | | | | | | | |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 1+ | ... | 1+ | ... | D. | 1+ | ... | ... | 2+ | ... | 1+ | 1+ | D. | Slightly inflamed |
| ... | ... | 1+ | 1+ | 1+ | 1+ | ... | 1+ | 1+ | D. | 1+ | ... | ... | Sl. | ... | 1+ | ... | D. | 4+ | 2+ | 3+ | 1+ | Few | Few | 3+ | D. and F. | Cholangeitis in liver |
| ... | ... | ... | ... | 3+ | 1+ | 1+ | ... | ... | ... | ... | ... | 2+ | 3+ | 3+ | Few | Few | D. | 1+ | 1+ | 3+ | 1+ | 1+ | ... | ... | D. | Prolonged low grade infection |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 1+ | ... | ... | 1+ | ... | 1+ | ... | D. | 1+ | ... | 1+ | ... | ... | 1+ | 1+ | D. and F. | |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | Normal microscopic picture |
| 1+ | D. | 2+ | 0 | 0 | 2+ | 2+ | 2+ | 1+ | D. | ... | ... | ... | 2+ | 1+ | 2+ | 1+ | D. | 1+ | ... | 1+ | 1+ | 1+ | 1+ | 1+ | D. | |
| ... | ... | 1+ | ... | 2+ | 1+ | ... | 1+ | ... | D. | 1+ | ... | 2+ | ... | ... | 1+ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | Only one section studied; calcification in wall |
| ... | ... | ... | ... | ... | Sl. | 1+ | 1+ | 1+ | D. | 2+ | 2+ | 1+ | 2+ | 2+ | 2+ | 2+ | D. | 4+ | ... | 4+ | Sl. | Few | Few | Few | D. | Histologic picture of early subsiding acute infection |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | Sl. | ... | ... | Sl. | ... | 2+ | 1+ | Pv. | ... | ... | ... | ... | ... | ... | ... | ... | Mechanical attacks |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 2+ | 2+ | ... | Sl. | ... | 1+ | Few | F. and Pv. | ... | ... | ... | ... | ... | ... | ... | ... | Hypertension from mechanical attacks |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | Sl. | ... | 1+ | ... | D. | 1+ | ... | ... | 1+ | ... | 1+ | ... | D. | |
| Infected sac. | | Various layers not clearly seen | | | | | | | | | | | | | | | | | | | | | | | | |
| ... | ... | ... | ... | ... | 1+ | 1+ | 1+ | 3+ | D. | ... | ... | 1+ | 2+ | 1+ | 1+ | 3+ | Pv. and F. | 1+ | 1+ | 1+ | 3+ | 2+ | 2+ | 3+ | D. and F. | |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | Normal gallbladder |
| ... | ... | 2+ | ... | 1+ | 1+ | ... | 1+ | ... | D. | 1+ | ... | ... | Sl. | ... | ... | ... | ... | ... | ... | ... | 1+ | ... | 1+ | ... | ... | |
| ... | ... | 2+ | ... | ... | 3+ | ... | 3+ | ... | D. | Nearly destroyed | 1+ | 4+ | 2+ | ... | ... | 2+ | D. | 2+ | 2+ | 3+ | 4+ | ... | ... | 4+ | ... | Fibrous wall |
| 3+ | D. | ... | ... | 3+ | 4+ | 4+ | ... | ... | D. | ... | ... | ... | 4+ | 4+ | 3+ | 3+ | D. | ... | 3+ | 3+ | 4+ | 3+ | 2+ | 2+ | D. | |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 2+ | ... | ... | Sl. | 1+ | ... | ... | D. | 2+ | 2+ | 2+ | 2+ | ... | 2+ | ... | D. | |

TABLE 2.—*Tabulation of Detailed Findings in*

| Name | History | Last Attack, Time Before Operation | Roentgen Examination | Gross Appearance of Gallbladder | Stones | White Blood Cells in Bile | Cultures | | Postoperative Course | Microscopic picture | | Mucosa | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Wall of Gallbladder | Bile | | Asymmetry | Rokitansky-Aschoff Sinuses | Ulcer | Cellular Infiltration | Polymorphonuclears | Lymphocytes |
| Clark | Pain; vomiting; jaundice, 5 years | Old | N.V. | Edema; soft adhesions | Yes | ..... | B. diphtheriae | .. | Smooth | ... | ... | ... | ... | ... | ... |
| Cowbey | Many typical attacks of colic | Old | V.: many stones | Normal; adhesions | Yes | ..... | Few strep. | S. | Smooth | ... | ... | ... | ... | ... | ... |
| Herbotsheimer | Many typical attacks of colic; no jaundice and fever | Old | N.V. | Large adhesions; thick | No | ..... | Str. viridans | .. | Uneventful | No | ... | ... | ... | ... | ... |
| King | Sense of indigestion; no typical attacks | Old | V. with stone | Normal; adhesions | Yes | ..... | B. welchii | B. welchii | Uneventful | ... | ... | ... | ... | ... | ... |
| Miller | Nausea; vomiting; not typical attack | Old | N.V. | Normal; adhesions | Yes | 1,180 | S. | S. | Uneventful | ... | 2+ | ... | ... | ... | ... |
| Mueller | Many afebrile attacks of colic for 1½ years; food intolerance for 8 years | Old | .. | Normal; distended | Yes | ..... | S. | S. | Uneventful | ... | ... | ... | ... | ... | ... |
| Vaso | Many acute attacks; ? ulcer | Old | N.V. | Normal; distended | Yes | ..... | ... | ... | Temp. 101 F. one week | ... | ... | ... | ... | ... | ... |
| Palt | Many attacks of colic with chills and fever; jaundice | Old | N.V. | Much thickened; normal | Yes | ..... | B. coli; B. welchii | B. coli | Uneventful | ... | ... | ... | ... | ... | ... |
| Poncillo | Stormy febrile attacks of colic for 4 months | Old (2 wks.) | N.V. | Shrunken | Yes | ..... | Not done | | Uneventful | ... | ... | ... | ... | ... | ... |
| Robellard | Atypical attack of colic in right upper quadrant; no fever or jaundice | Old | ? | Normal | No | 640 | Few staph; Strep. | S. | Uneventful | ... | ... | ... | ... | ... | ... |
| Russell | Many years indigestion; one attack of colic with jaundice 1 year before | Old | Faint | Thickened; not acutely inflamed | Yes | 1,250 | Staph. | Staph. | Uneventful | ... | ... | ... | ... | ... | ... |
| Russell | Few mild attacks of colic; no fever or jaundice | Old | Faint | Thickened ?? | Yes | 262 | S. | S. | Uneventful | ... | ... | ... | ... | ... | ... |
| Suss | Acute afebrile attacks of colic, 2 or 3 a year for 20 years | Old | N.V. | Thickened | Yes | 0 | B. coli | B. coli | Uneventful | 2+ | ... | ... | 2+ | ... | ... |
| Stengle | Many typical attacks of colic; jaundice once | Old | N.V. | Large and thick | Yes | 350 | Staph. subtilis | S. | Uneventful | ... | ... | Marked cholesterosis | | | |
| Frey | Attacks of colic for 4 years; also pain from ulcer | Old | Faint | Not thickened | Yes | 1,225 | B. coli; staph. | B. coli; staph. | Uneventful | ... | ... | ... | ... | ... | ... |
| Frost | Several attacks with jaundice | Old | N.V. | Slightly thickened | Yes | ..... | B. coli | B. coli | Some pain and fever | ... | ... | ... | ... | ... | ... |
| Johnson | Repeated attacks for 1 year; chills; jaundice | Old | V. | Slightly thickened | Yes | 450 | S. | S. | Uneventful | ... | 1+ | ... | ... | ... | ... |
| Logelin | Occasional attacks in last 3 years; no jaundice | 3 wks. | N.V. | Thin | Yes | ..... | Str. viridans; staph. | Gram-negative rod | Uneventful | ... | ... | ... | ... | ... | ... |
| Marks | Atypical abdominal pains; one typical attack recently | Old | V. | Normal | Yes | 2,460 | Staph.; B. welchii | Staph. | Uneventful | ... | 1+ | ... | ... | ... | ... |
| Prokop | Numerous atypical attacks | Old | Not done | ..... | Yes | 4,000 | S. | S. | ..... | ... | ... | Very thin gallbladder wall | | | |
| Thompson | Severe attacks for 3 years | 2 wks. | N.V. | Marked adhesions and edema | Yes | ..... | B. coli | B. coli | Uneventful | ... | ... | 3+ | 3+ | 3+ | 3+ |
| Wood | 3 attacks 12 years ago; recurrences in last 3 months | Weeks | Not done | Large, thick | Yes | 875 | Gram-negative rod | ..... | Uneventful | ... | 1+ | ... | ... | ... | ... |

*"Chronic" or Old Inactive Cases of Cholecystitis*

| | | Submucosa | | | | | | | | Muscularis | | | | | | | | Serosa | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Eosinophils | Distribution | Follicles | Edema | Fibrosis | Cellular Infiltration | Polymorphonuclears | Lymphocytes | Eosinophils | Distribution | Hypertrophy | Edema | Fibrosis | Cellular Infiltration | Polymorphonuclears | Lymphocytes | Eosinophils | Distribution | Edema | Fibrosis | Thickening | Cellular Infiltration | Polymorphonuclears | Lymphocytes | Eosinophils | Distribution | Comment |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 2+ | ... | ... | 1+ | ... | ... | 1+ | ... | 1+ | ... | F. and Pv. | Lymph channels in serosa had many lymphocytes |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 1+ | ... | 1+ | 2+ | ... | 3+ | 1+ | D. | 2+ | ... | ... | 2+ | ... | 2+ | 1+ | D. and Pv. | Fibrosis in muscularis |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | Sl. | ... | ... | 1+ | ... | 1+ | ... | R.V. | 1+ | 2+ | 1+ | 1+ | ... | 1+ | ... | Pv. | |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | Normal gallbladder |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | Sl. | ... | 1+ | ... | F. | ... | ... | ... | 1+ | ... | 1+ | ... | F. | Had dilated duodenum on roentgen examination before observation |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | Normal gallbladder |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | Normal gallbladder; duodenal ulcer; tuberculous lymph gland near cystic duct |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 1+ | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | Dilated lymphatics and follicles in muscularis |
| ... | ... | ... | 2+ | 3+ | ... | ... | ... | ... | ... | ... | 2+ | 4+ | ... | ... | ... | ... | ... | 3+ | 2+ | ... | ... | ... | ... | ... | ... | Fibrosis at gallbladder; cholecystostomy 4 years before |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | Normal gallbladder |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | Normal gallbladder |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | Operated on because of roentgen evidence of stone |
| 2+ | ... | Blends with mucosa | | | | | | | | ... | ... | 1+ | 2+ | ... | ... | 3+ | 2+ | ... | 3+ | ... | 1+ | ... | ... | ... | F. | |
| | | ... | ... | 2+ | ... | ... | ... | ... | ... | Atrophy | 4+ | ... | ... | ... | 4+ | D. | | 4+ | 3+ | ... | 4+ | ... | ... | 3+ | D. | |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | Normal gallbladder |
| ... | ... | 2+ | ... | ... | 1+ | 1+ | 1+ | 1+ | D. | 3+ | ... | ... | 1+ | 1+ | 1+ | 1+ | D. | 1+ | 1+ | 1+ | 2+ | 2+ | 1+ | 2+ | D. | |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | Essentially normal |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 1+ | ... | ... | 1+ | ... | 1+ | ... | Pv. | Stone occluded cystic duct |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 1+ | ... | 1+ | ... | 1+ | ... | Pv. | |
| 3+ | D. | ... | ... | ... | 1+ | 1+ | 1+ | 1+ | D. | 1+ | 2+ | ... | 3+ | 2+ | 2+ | 2+ | D. | 1+ | 2+ | 2+ | 4+ | 4+ | 4+ | 3+ | ... | Abscesses in serosa |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | Atrophy | ... | ... | ... | ... | ... | ... | ... | 2+ | 1+ | 1+ | 1+ | ... | 1+ | ... | F. and Pv. | |

pictures they must be reviewed here. Cultures were planned so as to attempt to grow both the aerobic and the anaerobic organisms. Furthermore, the fluid content of the gallbladder was plated, and the number of bacteria per cubic centimeter was determined. The results of these studies showed clearly that the number of bacteria in the bile or fluid contents of the gallbladder in practically all cases was very small. Various organisms were found, but their numbers were generally under 100 per cubic centimeter of bile, a finding hardly consistent with a theory that cholecystitis is an infection. It was, furthermore, very noticeable that the number of cases in which there were bacteria in the wall of the gallbladder considerably exceeded those in which there were bacteria in the bile, indicating that whatever infection was present had been derived from the adjacent organs or the blood and not from the bile. It was astonishing that the number of organisms found in the acutely inflamed gallbladders did not, as a rule, exceed those found in the quiescent cases. It was striking that cultures from three of the four most severely damaged gallbladders were sterile. Of the thirty-six cases in our series in which operation was done during an acute attack or immediately afterward (5 days), bacteria were found in the wall in 42 per cent and in the fluid contents in 42 per cent, while in only 6 per cent were there high colony counts. This contrasts but slightly with the series of quiescent cases, in which bacteria were found in the wall in 33 per cent and in the fluid contents in 25 per cent, with high colony counts in 8 per cent. These figures are in general accord with the many previously reported series of cultures reviewed by Magner and Hutcheson.[5] Judd, Mentzer and Parkhill[6] commented on the fact that cultures in many cases of acute cholecystitis are sterile. Haase[7] found them to be sterile in 36 per cent of all cases. Seeber[8] divided his cases into afebrile and febrile groups. Cultures were sterile in 50 per cent of the cases without fever and in 25 per cent with fever. From the foregoing data there is but one conclusion to be drawn, i. e., that in the average case of biliary colic infection plays but a minor rôle.

### ASYMMETRY OF PATHOLOGIC PROCESS

Our experience has indicated that a single section of the wall of a gallbladder is of rather doubtful significance. When serial sections are

5. Magner, W., and Hutcheson, J. M.: Cholecystitis, Canad. M. A. J. **27**:469, 1932.

6. Judd, E. S.; Mentzer, S. H., and Parkhill, E.: Bacteriologic Study of Gall-Bladders Removed at Operation, Am. J. M. Sc. **173**:16, 1927.

7. Haase, W.: Untersuchungen operativ entfernter Gallenblasen auf ihren Keimgehalt, Beitr. z. klin. Chir. **152**:305, 1931.

8. Seeber, F. L.: Klinische und bakteriologische Untersuchungen bei Erkrankungen der Gallenwege, Deutsches Arch. f. klin. Med. **167**:186, 1930.

made, it at once becomes clear that asymmetry of two types is frequently encountered. First, there is a considerable tendency for the sections nearest the fundus to show the most advanced changes (fig. 2). Second, in several of our cases there was a high degree of patchiness of the infiltration. This fact has been commented on by Feinblatt [9] and by Denton.[10] The latter regarded it as evidence that the underlying cause of the lesion is a vascular damage and that it corresponds to areas in

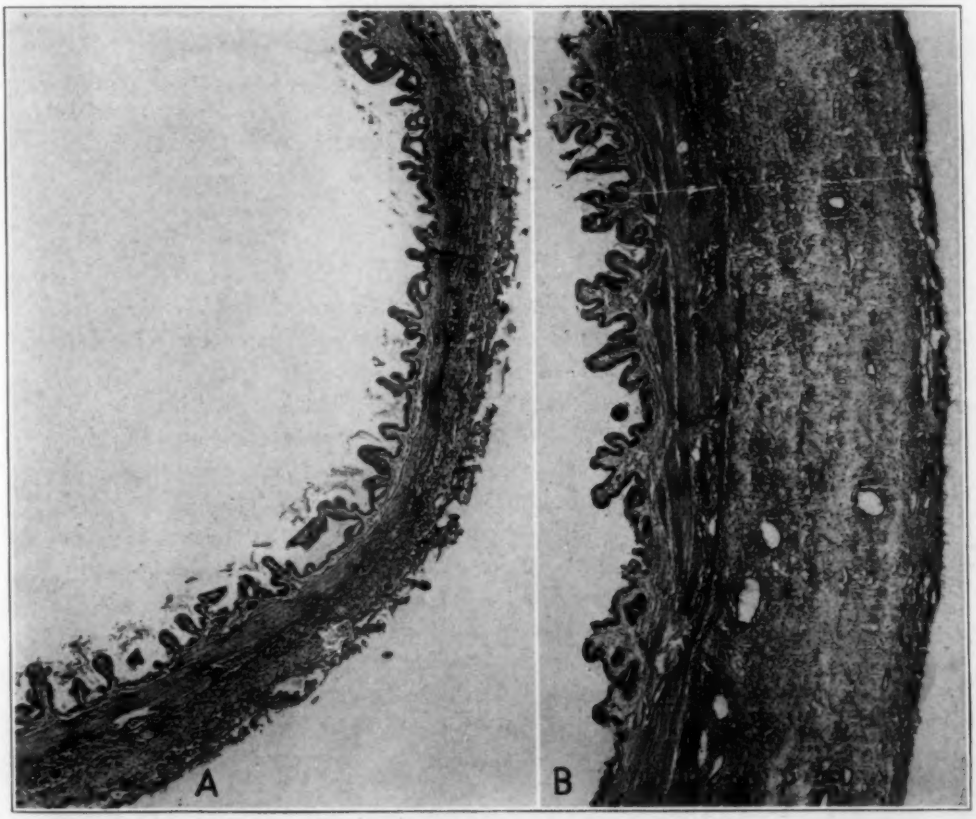


Fig. 2.—Photomicrographs showing different parts of the same gallbladder: *A*, a section near the duct of a practically normal gallbladder; *B*, a section near the fundus. Slight infiltration and marked edema and thickening of the serosa are seen. The picture is typical of cholecystitis of the moderate acute type.

which the blood supply is impaired. It was often much more marked on the hepatic surface of the gallbladder than on the free peritoneal edge.

9. Feinblatt, H. M.: The Infrequency of Primary Infection in Gall-Bladder Disease, New England J. Med. **190**:1073, 1928.

10. Denton, J.: The Mode of Origin of Gallbladder Disease, Arch. Surg. **14**:1 (Jan.) 1927.

This phenomenon has been discussed by one of us in a previous paper [11] and is believed to be an indication that infection, when it occurs, spreads by direct continuity from the liver, which it is known, has normally a rich bacterial flora.[3]

### ROKITANSKY-ASCHOFF SINUSES

The Rokitansky-Aschoff sinuses were noted in a fairly high percentage of cases. However, in no case was it possible to trace any of the pathologic changes to them. They frequently passed through all the layers of the wall and had small dilatations on the peritoneal surface, and one wonders why they did not rupture under stress. Nevertheless, while focal infiltration of the wall of the gallbladder was common in our studies, there was not a single case in which these sinuses showed that they might be the foci of infection. This again is a strong argument against any theories of infection of the gallbladder of biliary origin.

### ULCERS

Ulcers within the gallbladder are frequently mentioned in pathologic discussions, but in our experience they have been excessively rare, a true ulceration being present in only two of fifty-four cases. When the gallbladder is removed according to the technic described, without handling or squeezing or rubbing the wall against a gallstone, one does not find gaps in the mucosa. In almost every section of gallbladders removed without handling, the mucosa and its villi are absolutely intact and normal in appearance. Graham [12] called attention to the rapid autolysis of the mucosa of the gallbladder. It will, he said, entirely disappear in from five to six hours unless fixed. We have frequently noted the same fact in the gallbladder both of dogs and of human beings. There is also an intermediate stage in which the mucosa can be seen as a faint but distinct shadow in perfect outline, but which absolutely resists all staining. Care must be taken to differentiate this condition from necrosis of the inner coat. This leads one to suspect that many of the previously reported cases of ulceration of the wall of the gallbladder are due to artefacts of surgical trauma or to delay in fixation of the specimen.

### THE THICKENED GALLBLADDER

Studies of the thickness of the wall of the gallbladder at first gave rise to very great confusion as the gross findings and the operative report often apparently disagreed with the microscopic data. A common incident was to find in the operative report that the surgeon had removed a large, white, thick-walled gallbladder and to find on preparation of the

11. Andrews, E., and Hrdina, L.: Hepatogenous Cholecystitis, Arch. Surg. **23**:201 (Aug.) 1931.

12. Graham, E. A.: Diseases of the Gallbladder and Bile Tracts, Philadelphia, Lea & Febiger, 1928.

gross material in the pathologic laboratory that the wall was 10 mm. thick and that the viscus stood open of its own strength when empty. It was then very disconcerting to find on section that the wall was only slightly thickened and that it might appear practically normal. These experiences were so striking that we feared at first that the operative specimens were mislabeled. But subsequent study gave the correct answer to the problem. This is that in a general way most of the thickening of the wall of the gallbladder is edema. This was amply confirmed by our histologic studies. It is quite clear that the hardening and dehydration of a specimen would abolish much of this edema. The opposite occurrence was also not infrequent, that is, that an apparent thickening of the wall might take place during the process of fixation. This would probably depend on the degree of muscular contraction of the viscus at the time of its removal. A gallbladder which was distended might contract markedly either after or before fixation and appear thicker.

We believe that this factor of edema in disease of the gallbladder is the most characteristic feature of the pathologic picture. It takes place almost solely in the subserous layers, and it has proved striking that in our whole series the thickening of those gallbladders which were thicker than normal was due in at least 90 per cent of the cases to edema. Both Denton [10] and Feinblatt [9] commented on the importance of edema in the pathologic appearance of the gallbladder.

### EMPYEMA OF THE GALLBLADDER

In our experience empyema never occurs. It has been diagnosed repeatedly in the operating room when a creamy or milky content was found. However, in not a single case has the diagnosis stood up under chemical and microscopic examination. Invariably the milky fluid has proved to be either an emulsion of calcium carbonate or an emulsion of amorphous or crystalline cholesterol. It may be entirely dissolved by the addition of acid or by the addition of lipoid solvents. In a long series of counts of the white blood cells in the bile the surprising fact has come to the fore that not only are they not present in larger amount in acute cases but their numbers actually lessened during periods of activity of disease of the gallbladder. In many of the acute cases the cell content is markedly reduced. Feinblatt [9] emphasized this point. In the cases which he studied there were twenty in which the appearance was that of empyema. He said: "The great majority of direct smears failed to reveal frank pus; that is large numbers of polymorphonuclear cells with ingested bacteria. . . . In only 40 per cent of cases did the pus-like material give positive cultures." An especially illuminating case was observed at the University Clinics recently, in which a large abscess beside the gallbladder was evacuated, the con-

tents of which on microscopic examination showed practically no leukocytes. Denton,[10] who studied six hundred cases, arrived at the same conclusion. He said "Microscopic examination of the fluid in the gallbladder supported this view for it was ordinarily found that it contained very few cells of any description and was not pus," and "What is commonly referred to as empyema of the gallbladder would usually be described by some other term if the contents were examined microscopically."

TABLE 3.—*Tabulation of Detailed Findings in Cases in Which Disease of*

| Name | History | Last Attack, Time Before Operation | Roentgen Examination | Gross Appearance of Gallbladder | Stones | White Blood Cells in Bile | Cultures: Wall of Gallbladder | Cultures: Bile | Postoperative Course | Microscopic picture: Asymmetry | Microscopic picture: Rokitansky-Aschoff Sinuses | Mucosa: Ulcer | Mucosa: Cellular Infiltration | Mucosa: Polymorphonuclears | Mucosa: Lymphocytes | Eosinophils | Distribution | Follicles | Edema |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Burge | ..... | .... | .. | Normal gallbladder | .... | ..... | ..... | ..... | Died 2 days after operation | | | | | | | | | | |
| Haggerson | Pain in right upper quadrant; atypical diarrhea | Old | V. | Normal; adhesions | Yes | 873 | S. | S. | Stormy; acute dilatation of stomach | No | None | Sl. | cholesterosis | | | | | ... | ... |
| Krader | No symptoms of gallbladder disease | .... | V. | Normal | Yes | ..... | S. | S. | Uneventful | No | 2+ | ... | ... | ... | ... | ... | ... | ... | ... |
| McLean | No symptoms of gallbladder disease; vague abdominal pain | .... | V. | Normal | No | 3,700 | Staph. | S. | Uneventful | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| Pederson | Operation for abdominal ulcer; no attacks of colic | Ulcer pain is constant | Not done | Normal | Yes | ..... | M. flavus | S. | Uneventful | Marked | ... | ... | ... | ... | ... | ... | ... | ... | Sl. |
| Trilling | Duodenal ulcer | Old | Not done | Normal | Yes | ..... | Staph. | S. | 104 F. for 2 days | ... | 2+ | ... | ... | ... | ... | ... | ... | ... | ... |
| Baum | Cholecystostomy 6 years ago; no typical history | None | V., with stones | Buried in dense adhesions | Yes | ..... | B. Welchii | S. | Uneventful | ... | 2+ | ... | ... | ... | ... | ... | ... | ... | ... |

Of course, it is impossible to state that empyema of the gallbladder does not occur. We are simply recording the fact that in every case that we have observed in which the condition was thought to be empyema it has proved not to be.

## CHOLESTEROSIS

Our own experience as well as theoretical considerations do not put great importance on cholesterosis. In the first place, it is found exactly as frequently in the normal as in the abnormal human gallbladder. No evidence has been produced which would indicate its association with cholesterol stones. Cholesterosis of the gallbladder is exceedingly common in several of the experimental animals, and in some of the herbivor-

ous animals it is so frequent that it is the rule and not the exception. In view of the fact that a cholesterol gallstone has never been reported as either occurring spontaneously or being produced in any animal experimentally, it seems rather far-fetched to associate cholesterosis with cholesterol gallstones in human beings. In our experience it has occurred no oftener in one type of gallbladder than another and no oftener with cholesterol stones than without them, and we believe that its occurrence may be ignored. Graham and Mackey,[13] who on the other

*Which Disease of the Gallbladder Was Clinically Questionable*

| | | Submucosa | | | | | | | | Muscularis | | | | | | | | Serosa | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Eosinophils | Distribution | Follicles | Edema | Fibrosis | Cellular Infiltration | Polymorphonuclears | Lymphocytes | Eosinophils | Distribution | Hypertrophy | Edema | Fibrosis | Cellular Infiltration | Polymorphonuclears | Lymphocytes | Eosinophils | Distribution | Edema | Fibrosis | Thickening | Cellular Infiltration | Polymorphonuclears | Lymphocytes | Eosinophils | Distribution | Comment |
| | | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | Normal gallbladder |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 2+ | ... | 1+ | ... | D. and F. | |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | Normal gallbladder |
| ... | ... | ... | Sl. | ... | ... | 1+ | 1+ | 2+ | D. | 2+ | ... | ... | 3+ | 1+ | 1+ | 3+ | D. | 1+ | ... | ... | Sl. | 1+ | ... | 1+ | Pv. | Fundus and cystic duct normal; inflammation in medial portion |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 1+ | ... | ... | ... | ... | ... | ... | 2+ | Sl. | ... | ... | ... | ... | ... | ... | Had duodenal ulcer with stenosis |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | Sl. | 1+ | ... | 1+ | ... | 1+ | ... | F. and Pv. | 1+ | 1+ | 1+ | 2+ | ... | 1+ | Few | F. and Pv. | |

hand expressed the belief that it is of pathologic significance, reported it to be a common finding in otherwise normal gallbladders and stated, furthermore, that removal of the gallbladder for cholesterosis alone yields poor results. Aschoff,[14] Boyd,[15] Feinblatt [9] and many others have found it with special frequency in the normal viscus.

13. Graham, E. A., and Mackey, W. A.: Consideration of the Stoneless Gallbladder, J. A. M. A. **103**:1497 (Nov. 17) 1934.

14. Aschoff, L.: Lectures on Pathology, New York, Paul B. Hoeber, Inc., 1924.

15. Boyd, William: Surgical Pathology, ed. 3, Philadelphia, W. B. Saunders Company, 1933.

### CELLULAR INFILTRATION

If one compares the degree of inflammatory process in even an acutely infected gallbladder with that present in other viscera when acutely infected, one is at once impressed with the relative paucity of infiltrating cells. If, for example, a section of an infected urinary bladder or appendix is compared with one of the gallbladder, the fact is striking that the gallbladder, although it may be enlarged, thickened, dense or hard, has a relatively far smaller number of infiltrating leukocytes. The gallbladder, a section of which is shown in figure 3, was the fifth most severely involved in our entire collection, and it will be seen at once that it does not compare qualitatively with the inflamed urinary bladder or appendix. This is another clear indication of the fact that disease of the gallbladder in general is not simply an acute inflammation but a reaction of an entirely different sort.

Not only is the inflammation different in degree but in kind. The predominant cells in inflammation of the gallbladder in our series were not polymorphonuclear leukocytes. These do not occur regularly in the inflamed gallbladder in great numbers, and when they are present they generally are shadowed by the lymphocytes. The one clear feature was that the large number of eosinophils encountered in some cases was clearly associated with the subsidence of the disease, so that the eosinophilia of the gallbladder was an indication of progressive recovery. Of the infiltrating cells, the average of the whole series was at least ten to one round cells, there being more mononuclears than polymorphonuclears. Several cases were found, not only acute but quiescent ones, in which there was marked hypertrophy of all the lymphoid elements; the follicles in the submucous layers were hypertrophied, and the entire wall of the viscus was full of areas of dense focal infiltration of small lymphocytes. The occurrence of these in a normal gallbladder and the frequent finding in the dog of considerable lymphocytic infiltration of the wall of the gallbladder incline one to doubt if this represents an actual disease phenomena or is part of a general lymphatic hyperplasia (fig. 4). Marked hyperplasia of the submucosal lymph follicles is a common finding in appendixes that are not inflamed.

The type of infiltration that occurred was classified as focal, perivascular or diffuse, and when the entire series is summed up it is impossible to state what significance each variety has.

*The Mucosa.*—With but three exceptions in the acute series and one in the quiescent series the mucosa was normal, having no infiltration of wandering cells. In view of the many cases in which the mucosa appeared normal while the other layers showed marked evidence of reaction, one feels justified in arguing that whatever infection was involving the wall of the gallbladder it did not originate in the bile.

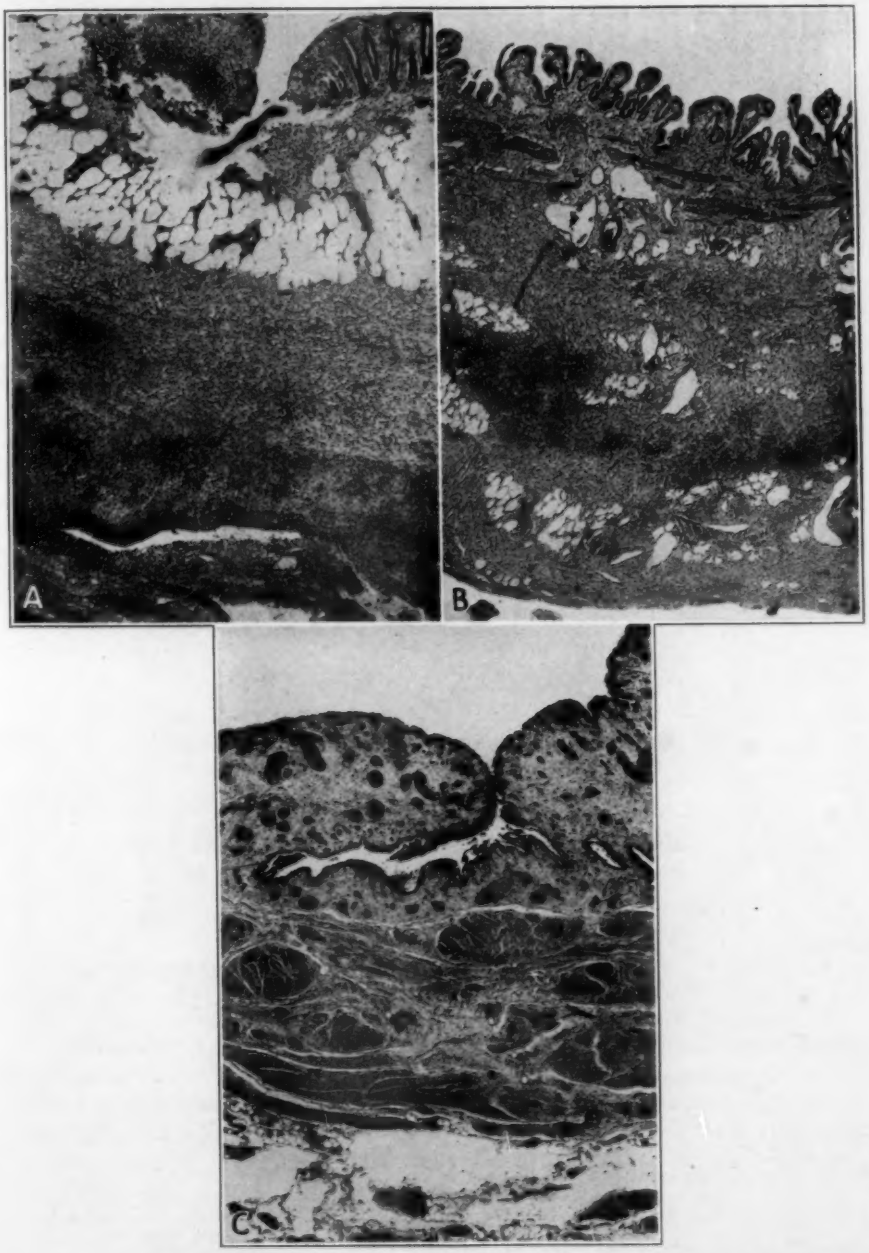


Fig. 3.—Photomicrographs for a comparison of acute infections of the gallbladder, appendix and urinary bladder. *A*, a section of the appendix, showing ulceration of the mucosa, extensive infiltration of the submucosa, muscularis and serosa with polymorphonuclear leukocytes and fibrinous exudate over the serosa. *B*, a section of the gallbladder with the mucosa intact and the submucosa normal. There is slight cellular infiltration of the muscularis (mostly round cells). Enormous edema and infiltration of the serosa produced marked thickening of the wall. *C*, a section of the urinary bladder showing enormous hyperemia and edema of mucosa, with moderate infiltration; moderate infiltration of the submucosa, and an essentially normal muscularis.

In studying the mucosa of a gallbladder several points must be kept in mind: First, there is the unusual tendency for the mucosa to undergo autolysis. Second, the damage from operative trauma on this very delicate membrane with long, thin villi is likely to be mistaken for pathologic change. We have attempted to avoid this when possible and thus to separate real changes from artefacts. Third, many writers have failed to recognize the fact that the normal mucosa of the gallbladder contains large numbers of cells which are quite similar to those which infiltrate the other coats in disease. Graham [16] said: "Normally, the mucosa contains *large numbers* of round cells (lymphocytes)." While he said that the mucosa is "relatively intact" and that most of the infiltration is in the deeper layers, Boyd [15] went considerably further. "It is

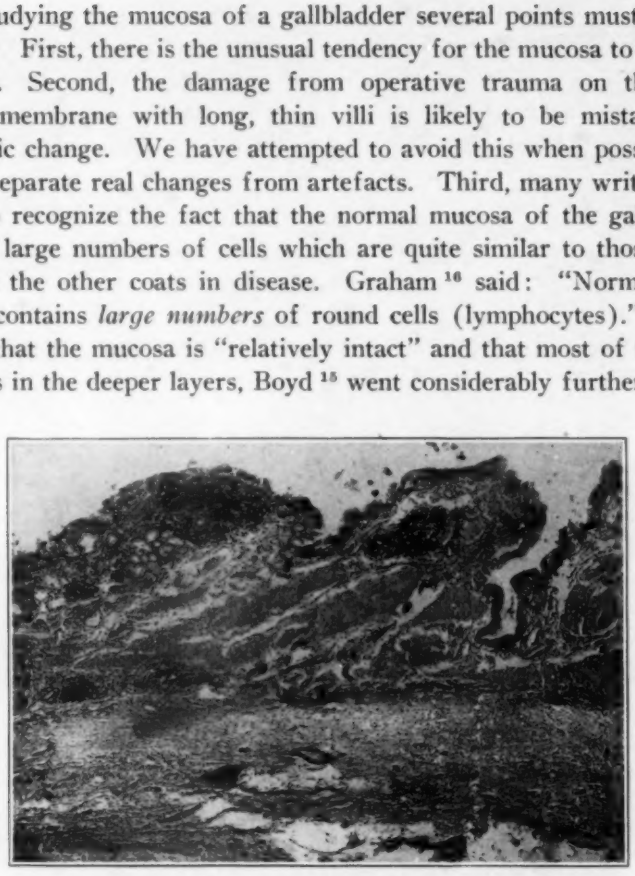

Fig. 4.—Photomicrograph of a section of a lymphoid gallbladder. The patient had had many attacks of colic, but none had occurred for many months. There were no signs of activity at the time of operation. There were stones in the bladder, but the ducts were free. Many enlarged lymph follicles are seen in the mucosa and the submucosa, and occasionally in the muscularis. Moderate focal infiltration of small lymphocytes is present in all layers. As far as we know, these follicles, which are often present, do not enlarge in real disease of the gallbladder. We are inclined not to regard such changes as signs of infection.

remarkable," he said, "how intact the mucosa may be in the worst looking gall-bladder." Our own experience agrees with Boyd's.

*The Submucosa.*—This layer enjoyed also the relative freedom from cellular infiltration that the mucosa did, although the normal lymphoid follicles varied considerably. In no case was either the mucosa or the submucosa infiltrated with cells when the outer layers were normal.

*The Muscularis.*—The muscularis and subserous layers were generally involved together with any pathologic process. Hypertrophy of

16. Graham,[12] p. 132.

the muscular wall did not appear to be associated with the presence of stones, nor did atrophy, which occasionally occurred. However, in the thickening of the wall, which occurred in many cases, the muscularis seldom takes an important part. Edema may take place with a slight spreading of the fibers, and a diffuse infiltration is common. However, although it may be thickened to double its normal extent in extreme cases, it never reaches proportions commonly found in the serosa.

*The Serosa.*—Edema, infiltration, hemorrhage, deposit of fibrin and especially dilatation of the lymphatics in the subserous layers account for practically all the thickening of the inflamed gallbladder. In every case it is the serosa which bears the brunt of the process, and its involvement is invariably greater than that of any of the other layers (fig. 5).

## PATENCY OF THE CYSTIC DUCT

One of the most striking findings in our studies has been the definite correlation of the condition of the cystic duct with the pathologic changes in the gallbladder. This has been a far more accurate correlation than the presence of stone. With two or three exceptions gallstones were found in all our cases. But it was very striking that there was far less pathologic changes in the cases in which visualization under the x-ray indicated that the cystic duct was patent than in cases in which there was failure of visualization or in which operation revealed that the duct was closed. Examination of tables 2 and 3 reveal this fact sharply, and it is the one clinical correlation which has worked without exception.

## FEVER

If the foregoing conception of cholecystitis is correct, it is difficult to account for the fever which often occurs, as fever is usually attributed to infection, which we do not believe to be a prominent feature. The evidence for this recently summed up is not only the failure of ourselves and practically all other observers to find bacteria in many cases of acute or chronic disease of the gallbladder (the cultures were sterile in an actual majority of even our acute cases) but the histologic studies of Feinblatt [9] and of Denton [10] as well as our own. Denton sectioned seventy acutely diseased gallbladders, and bacterial stains revealed organisms only in four.

A review was therefore made of the cases studied in which there was a temperature of over 100 F. while the patient was under observation or in which definite chills were reported. These manifestations seem to occur in only a minority of attacks. Many of the gallbladders which appeared the most diseased histologically had not caused fever in recent attacks while the patient was in the hospital. Closure of the

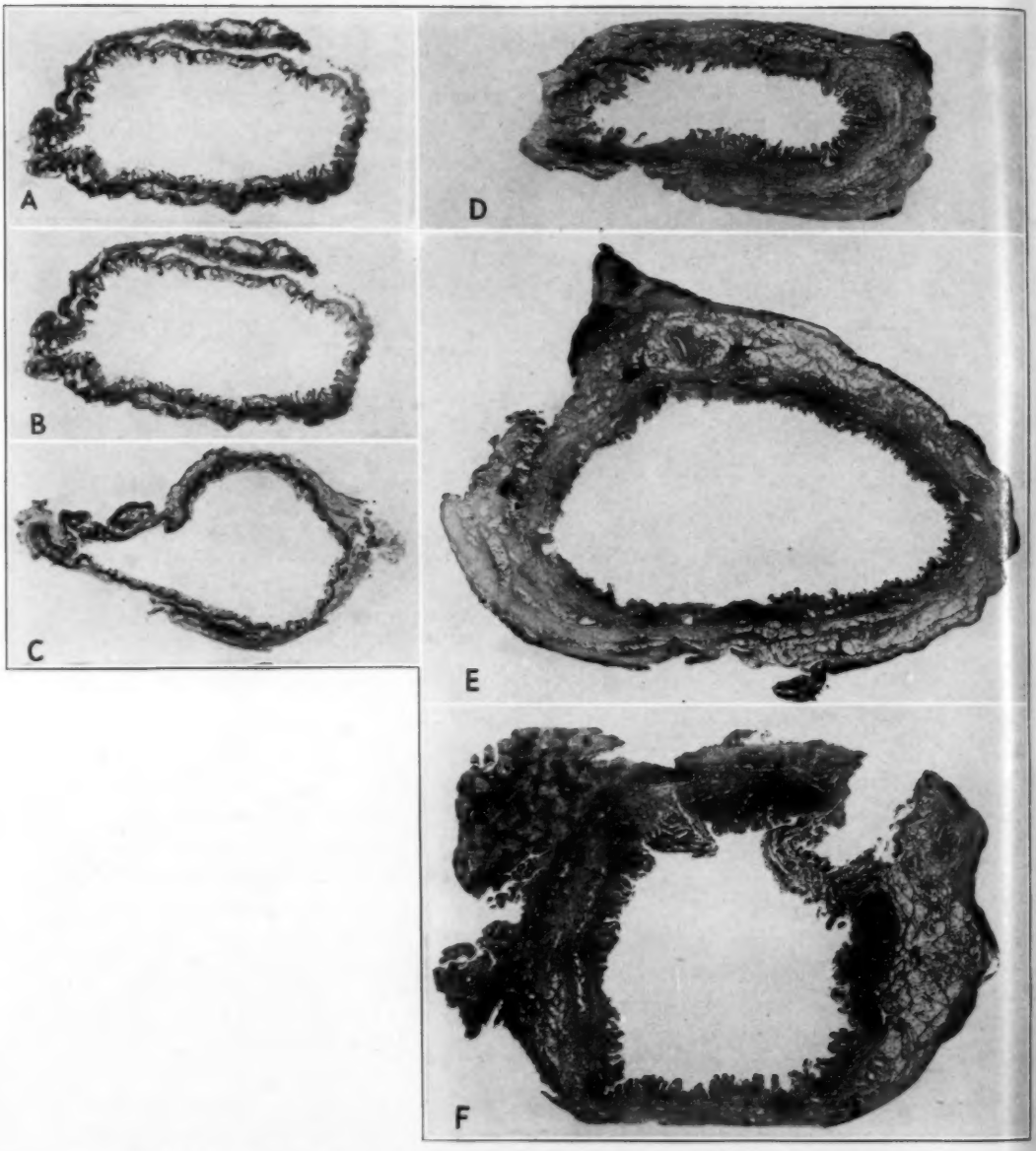


Fig. 5.—Sections through three different portions of a normal gallbladder (*A*, *B* and *C*) and of a thickened gallbladder (*C*, *D* and *E*). The measurements are as follows: *A*, *B* and *C*, the mucosa, 3 mm.; the muscularis, from 1 to 2 mm.; the serosa, from 2 to 5 mm.; *D*, *E* and *F*, the mucosa, from 3 to 5 mm.; the muscularis, from 2 to 3 mm., and the serosa, from 15 to 20 mm.

cystic duct alone did not appear to be in any way connected with the onset of fever, as it was often present both acutely and chronically without having produced fever. The one phenomenon that was definitely so connected was interference with the common duct. Twenty-eight patients were studied (the data on all are not included in the tables). Eleven had gross jaundice, and eight more, an elevation in the icteric index. One passed a single white stool on the second day of her attack; three on operation were found to have unsuspected calculi of the common duct, and four of the remaining five had massive inflammatory edema about the junction of the cystic and common ducts, in three cases accompanied by stones impacted in the cystic duct.

It is therefore clear that the age-old conception of "Charcot's intermittent fever" is not simply a manifestation of stone in the common duct. Obstruction of the common duct by inflammatory exudate about its junction with the cystic duct is probably relatively commoner than is indicated in the foregoing figures, because they were obtained by searching for records of obstruction of the common duct in our tables. It is well known that most cases of partial jaundice are to be explained on this basis. We believe that this is also the usual explanation of fever in cases of disease of the gallbladder.

## COMMENT

No classification of diseases of the gallbladder can be of any use to clinicians that is not founded on sound ideas of the etiology, and especially of the relation of infection to cholelithiasis. It is only when modern knowledge of this subject is included that a reasonable classification can be arrived at, one which will not clash glaringly with the clinical and bacteriologic pictures as the present ones do. Many of the older classifications were based on ideas that have of necessity been abandoned. These include the theory of diathesis of cholesterol to form stones and the older ideas that the cholesterol of stones is derived from the mucosa of the gallbladder. Finally, the age-old question as to which came first, the infection or the stone, has always been answered directly one way or the other, whereas modern research has shown the answer to be a very complicated one.

In order to lay a foundation on which to build a classification, it is necessary to review rapidly a few of the facts brought to light by recent researches. Space does not permit a full discussion of some controversial matters, but reference will be made to recent discussions of them.

1. Cholesterol stones are formed during short periods of obstruction[5] of the cystic duct. The solvent of cholesterol, bile salts, is then absorbed from the gallbladder, while the cholesterol remains and

crystallizes.[17] The cholesterol of stones is derived from the bile and not from the epithelium of the gallbladder.

2. Calcium is deposited from the mucosa of the closed gallbladder, being secreted by it.[18]

3. The closure of the cystic duct from any cause brings on an infection of the gallbladder which lasts for a variable length of time.[11] During this infective period calcium is not deposited.[19] As the infection subsides, the deposit of calcium commences.[18d]

4. Infection of the gallbladder through the bile of the liver is not likely. The liver acts as a very efficient filter, and intravenous injections of enormous amounts of bacteria are necessary to produce passage through into the bile.[20]

5. Deposits of pigment may at least be due to a diathesis as they occur in diseases with increased pigment in the blood (hemolytic jaundice). Cholesterol stones are not associated with hypercholesteremia.[21]

These points are today quite well authenticated, and, as can be seen, every feature is fairly clear except the immediate exciting cause of the first period of obstruction of the cystic duct. Later obstruction may clearly be due to stones, but what causes the first one? It cannot be a diathesis, as only pigmented stones originate thus, and most gallstones do not have a nucleus of pigment. A consideration of the normal anatomy of the cystic duct will show how slight the stimulus need be. It is small, and its wall is thick, very vascular and so deeply infiltrated

17. Andrews, E.; Schoenheimer, R., and Hrdina, L.: Etiology of Gallstones: I. Chemical Factors and the Role of the Gallbladder, Arch. Surg. **25**:796 (Oct.) 1932. Ravdin, I. S.; Riegel, C.; Johnston, C. G., and Morrison, P. J.: Studies in Biliary Tract Disease, J. A. M. A. **103**:1504 (Nov. 17) 1934.

18. (*a*) Wilkie, A. L.: The Bacteriology of Cholecystitis, Brit. J. Surg. **15**:450, 1928. (*b*) Phemister, D. B.; Day, L., and Hastings, A. B.: Calcium Carbonate Gallstones and Their Experimental Production, Ann. Surg. **96**:595, 1932. (*c*) Phemister, D. B.; Rewbridge, A. G., and Rudisill, H.: Calcium Carbonate Gallstones and Calcification of the Gall-Bladder Following Cystic Duct Obstruction, ibid. **94**:493, 1931. (*d*) Andrews, E.; Dostal, L. E.; Goff, M. H., and Hrdina, L.: Mechanism of Cholesterol Gall-Stone Formation, ibid. **96**:615, 1932.

19. Andrews, E., and Hrdina, L.: Absorption of Calcium from the Gall-Bladder, Am. J. M. Sc. **181**:478, 1931.

20. Graham, E. A., and Peterman, M. G.: Further Observations on the Lymphatic Origin of Cholecystitis, Choledochitis and the Associated Pancreatitis, Arch. Surg. **4**:23 (Jan.) 1922.

21. Fox, F. W.: The Composition of Human Bile and Its Bearing on Sterol Metabolism, Quart. J. Med. **21**:107, 1927. Gardner, J. A., and Gainsborough, H.: Blood Cholesterol Studies in Biliary and Hepatic Disease, Quart. J. Med. **23**:465, 1930.

with gland and sinuses that the slight irritation would cause the swelling necessary to close it (fig. 6). Whether it is some transient infection from the blood, lymph (Graham [12]), liver (Andrews [11]) or bowel, or whether it is a chemical irritation (Mann's cholecystitis produced by surgical solution of chlorinated soda [Dakin's solution] [22]), or perhaps the regurgitation of pancreatic juice (Wolfer [23]) cannot at present be answered. Allergic disease, as recently suggested by Alvarez [24] and by Deissler and Higgins,[25] must also be considered. The important point is that this mechanism need act but once, and each subsequent attack can be explained by the stones which result from the previous ones. This is quite consonant with the fact that in our series stones were practically always present. The rare cases in which they are not found are easily explained on the basis that they have been passed or, as has already been suggested, on the basis of faulty diag-

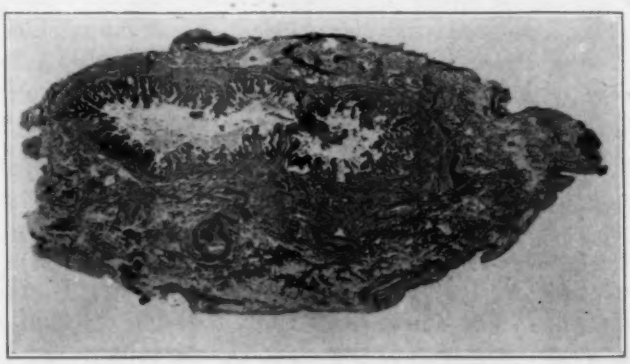

Fig. 6.—Photomicrograph showing the region of the duct of a normal gallbladder. Note the complexity of the papillae and the mucosal valves. The main artery is in close contact with the duct. Many large arterioles lie actually in and in contact with the muscular wall. It is obvious that a slight inflammatory edema or impacted stones not only would close the lumen but would compress the vessels.

nosis. While a gallbladder containing stones may show signs of severe inflammation, it is also only too true that many cases of so-called cholecystitis without stones have failed to stand the acid test of the follow-up clinic, which is the only way of ascertaining that the gall-

22. Mann, F. C.: Production by Chemical Means of a Specific Cholecystitis, Ann. Surg. **73**:54, 1921.

23. Wolfer, J. A.: The Role of Pancreatic Juice in the Production of Gall-Bladder Disease, Surg., Gynec. & Obst. **53**:433, 1931.

24. Alvarez, W. C.: Pseudocholecystitis Apparently Caused by Food-Sensitiveness, Proc. Staff Meet., Mayo Clin. **9**:680, 1934.

25. Deissler, K., and Higgins, G. M.: Proc. Staff Meet., Mayo Clin. **9**:678, 1934.

bladder was really the cause of the symptoms, which are often blamed on microscopic changes which are rather slight. Denton [10] found that of two hundred and fifteen gallbladders without stones, only nineteen showed definite pathologic changes.

### AUTHOR'S CLASSIFICATION OF DISEASE OF THE GALLBLADDER

With the foregoing points in view the following classification of disease of the gallbladder is constructed. Into it may be fitted all cases without discordance in the pathologic picture and the clinical findings. Most of the older classifications have been based on the presence or absence of stones, together with the presence or absence of signs of infection, and all the other important criteria, clinical, chemical and bacteriologic, have been ignored. Recent work seems to indicate that infection is not a prominent feature. Cultures in most cases of acute and chronic cases of disease of the gallbladder yield surprisingly similar results. The finding of a normal gallbladder containing stones is commonplace. The important feature, the real factor which influences the development of the pathologic picture as well as the course of the disease clinically, is the question of the patency of the cystic duct. The following classification uses this as a basis.

A. Normal state of the gallbladder
   - Slight infiltration often seen; cholesterosis: presence or absence of stones. (The presence of these signs formerly often led to a diagnosis of chronic cholecystitis.)

B. Reaction to acute obstruction of the cystic duct
   - Uncomplicated type (formerly called chronic cholecystitis)
   - Infective type (formerly called acute cholecystitis)
     - Empyema (?)
   - Type with vascular damage (formerly acute cholecystitis)
     - Mild cholecystitis
     - Ulcerative cholecystitis
     - Gangrenous cholecystitis

C. Reaction to intermittent obstruction of the cystic duct
   - Normal condition between attacks
   - Persitent irritation (usually mild)

D. Reaction to chronic obstruction of the cystic duct
   - Uncomplicated type (formerly called chronic cholecystitis)
   - Acute reinfection
     - Mild
     - Empyema (?)
   - Hydrops

E. Reaction to obstruction of the common duct
   - Acute or recent type (dilated and thin-walled gallbladder)
   - Chronic type (shrunken and fibrosed gallbladder)

F. Neoplasms

Our own observations are in accord with those of Denton and of Feinblatt,[9] i. e., that the underlying lesion is in most cases vascular. Denton quite aptly likened acute cholecystitis to a hemorrhagic infarct. The predominating factors in the picture are edema, hemorrhage and infiltration, with large and small mononuclear cells. Thromboses are not common, but the veins especially are dilated. Most students recognize that the tortuous venous plexus (anatomic studies by Karlmark [26]) about the cystic duct is the vulnerable point and that the arteries run somewhat farther off and are not so liable to injury. Whether the process is initiated by an impacted calculus or by edema from some other source, the results are the same and the clinical syndrome produced is the same.

A. *Normal State of the Gallbladder.*—Infiltration of the gallbladder with lymphocytes is normal. Control specimens both from animals and human beings show that a few patches may occur. Lymphoid follicles in the submucosa may be numerous (fig. 4). It is a question if the few cases with extensive pure lymphoid infiltration may not be included in this group. Cholesterosis is common.

The bile is acid. Its $p_H$ lies between 6.8 and 7 in the ordinary case in which the patient has been starved for from twelve to fifteen hours before operation. Drury, McMasters and Rous [27] have shown that the gallbladder progressively acidifies bile that lies in it. Their figures for the bile from dogs as well as those for many of our own cases lie considerably more on the acid side. While gallbladders with patent ducts, irrespective of their condition, have contained bile in this $p_H$ range, that of the bile from diseased gallbladders has varied widely. The bile from three cases of diseases of the gallbladder in human beings with a high calcium content typical of an obstructed gallbladder has shown a $p_H$ considerably more alkaline, while in other cases, especially in the active stage, the figures have been lower. Sufficient material is not at hand to make it possible to draw definite conclusions, but one is tempted to assume that the acutely (recently) obstructed gallbladder acidifies the bile rapildy and that after prolonged obstruction, when the reaction has subsided, alkalinization takes place. This, of course, fits in with the deposit of calcium in such cases,[18b] as calcium is less soluble in alkaline solutions. It contains no cholesterol crystals or undissolved amorphous cholesterol. It contains from 20 to 50 mg. per hundred cubic centimeters of calcium. The white cell count of the bile ranges from 2,000 to 5,000 per cubic centimeter. The cholesterol content of the bile

26. Karlmark, E.: Dielokalisationstendenz bei Metastasierung durch die Venen in die Leber, Acta path. et microbiol. Scandinav., supp. 13, 1932, p. 1.

27. Drury, D. R.; Rous, P., and McMaster, P. D.: Some Causes of Gallstone Formation: III. Relation of Reaction of Bile Experimental Cholelithiasis, J. Exper. Med. **39**:403, 1924.

is less than one-thirteenth the bile salt content. The cystic duct is patent. (We have never observed cholesterol crystals in true liver bile.) Streptococci, staphylococci, Bacillus Welchii, Bacillus coli, Bacillus typhosus and other kinds of bacteria are frequently present, but in small numbers (under 200 per cubic centimeter). The wall may or may not contain the same flora.

B. *Reaction to Acute Obstruction of the Cystic Duct*—Uncomplicated Type: The characteristic feature in the gallbladder in which the disease arises from acute obstruction of the cystic duct is edema, which is most marked in the outer coats. There is an invasion, most marked in the outer coats of many round cells, and a relatively small number of polymorphonuclears. Eosinophils appear in large numbers as the process subsides. The cystic duct is closed. The fluid often contains cholesterol in crystals or in amorphous form. The calcium content is lowered. The bacterial count falls within the normal range, and culture of both bile and the wall may be sterile. The bile salt content is markedly lowered.

Infective Type: In this type there is a dense infiltration of all the layers of the gallbladder with polymorphonuclear leukocytes. Edema and thickening of the wall are more pronounced, especially in the subserous layers. The bacterial count will be enormously raised, especially in the stagnant bile. There is little or no increase in the cells in the bile. B. coli is a common finding in such cases.

Type With Vascular Damage: There are marked edema and thickening of the walls of the gallbladder, which are indistinguishable from these changes in the infective type. The infiltration, however, has far fewer polymorphonuclears except in the subsiding stages, when eosinophils are numerous. In addition, there are marked venous hyperemia and marked dilatation of the numerous lymphatic channels, especially in the subserous layers. The bacteriologic picture is normal, and sterile cultures are not uncommon. The mucosa is intact. Cholesterol crystals are common, and the calcium content is low. The bile salt content is also lowered markedly. Stones may or may not be present.

It is quite clear not only from our own findings but also from the recent literature indicating that cholecystectomy in the acute stage of disease of the gallbladder is usually safe that this type and not the infective type is the usual one in cases of so-called "acute cholecystitis." While I know of no means of differentiating these two groups preoperatively, it is interesting to note that Feinblatt's [9] studies of the cause of death following cholecystectomy showed that of twenty-three deaths none were due to acute peritonitis.

Ulcerative Cholecystitis: This condition is a complication of the type of disease of the gallbladder in which there is vascular damage.

Typical ulcers are rare. Most ulcers are really artefacts. Before making the diagnosis one should assure oneself that the gap in the mucosa is in reality lined with a pyogenic membrane. In view of the fact that ulcers have not been found except in the acute types of cases, we are justified in concluding that unless rupture takes place they heal rapidly with minimal scar formation, as even the scar of an ulcer has not yet been found in a quiescent case in our serial sections.

Gangrenous Cholecystitis: This type consists of a more extensive lesion of the vascular supply than that found in the ulcerative type. Thromboses in the vessels follow stasis, and necrosis, either total or partial, of the walls permits rupture. This being a complication which occurs only after acute obstruction of the cystic duct, in most cases much of the toxic bile salt content [28] has been absorbed and biliary peritonitis does not occur, but instead a walled-off abscess, usually containing necrotic material but no true pus.

C. *Reaction to Intermittent Obstruction of the Cystic Duct.*—The ability of the gallbladder to return to a normal state after the reactions of acute obstruction is interesting. Many cases have come to our observation in which severe repeated attacks of colic have left little doubt as to the diagnosis but in which an operation performed between attacks has disclosed a gallbladder with stones which was normal in every other way. Although in our microscopic studies we constantly searched for it, we could find no correlation between muscular hypertrophy and this factor. One fact, however, is striking. If the tables are examined it can be seen that there is a definite relationship between the patency of the duct and the extent of the pathologic process. The degree of infiltration is arbitrarily graded as 1, 2, 3 or 4 plus. If the average for the active and quiescent cases of disease of the gallbladder is found, one sees that the active cases average about the same as the quiescent cases (about 1.8 plus). However, if the cases in both groups are studied in relation to obstruction of the cystic duct, the surprising fact emerges that those with closed ducts (thirty-six) average 3 plus infiltration and those with patent ducts (twenty-two) average 0.5 plus.

These findings indicate clearly that the tendency of the gallbladder is to return to normal soon after an attack, providing that the duct reopens and that findings of residual infection indicate that the reestablishment of the flow of bile is faulty. This is probably the condition in the "grumbling gallbladder."

D. *Reaction to Chronic Obstruction of the Cystic Duct.*—In this type fibrosis of the wall of the gallbladder is marked. The mucosa is

28. Horrall, O. H., and Carlson, A. J.: The Toxicity of Bile, Am. J. Physiol. **85**:591, 1928. Rewbridge, A. G., and Hrdina, L.: Etiological Rôle of Bacteria in Bile Peritonitis, J. Exper. Biol. & Med. **27**:528, 1930.

intact but often atrophied, with small sessile villi. There may or may not be marked thickening, but if there is, it is chiefly in the subserosa. The infiltration is mostly of mononuclear types, and fibroblasts are common. The contents are often sterile, and the bacterial count is low, comparable to the normal value. The bile salts and pigment are absorbed from the bile, the former rapidly, in from two to four weeks, and the latter in from three to six months. The contents are thick. Cholesterol if still present is not in solution. The calcium content is very high, and often much amorphous calcium carbonate is precipitated. The reaction is alkaline. Stones may or may not be present.

Acute Reinfection: That this complication takes place is shown by cases with "white bile" and signs of acute or subacute infection. There is an increase in the amount of infiltration, which is composed of polymorphonuclear cells and a lowering of the $p_H$ of the fluid content.

Hydrops: Obviously this is a complication of chronic obstruction of the cystic duct, but just why the secretion of the mucosa of the gallbladder should be different in these cases is unknown. Clearly atrophy of the mucosa is the important element, but we are unable to state what the cause of the atrophy is.

Empyema: This might, of course, occur as a complication of either acute or chronic obstruction of the duct. The lack of such a case in our series and the proof that many apparent empyemas [29] are simple accumulations of cholesterol or calcium is not proof that it never occurs.

## SUMMARY

A study is reported of one hundred and sixteen surgically excised gallbladders, fifty-five of which were sectioned serially at intervals of 2 cm.

There was a total lack of the proper correlation between the pathologic classification of these cases and the clinical and bacteriologic findings.

The severely inflamed gallbladder contains about the same flora as the normal or quiescent one. It is very often sterile.

The degree of inflammation of the gallbladder is always greatest in the outer layers.

Edema plays the most prominent part.

The degree of inflammation is not dependent on the number of bacteria in the wall or in the bile. It is dependent on the patency of the cystic duct.

---

29. Feinblatt.[9] Denton.[10]

Fever probably originates from partial obstruction of the common duct, not in most cases from absorption of toxins or bacteria from the gallbladder itself.

In most so-called empyemas of the gallbladder the "pus" is really precipitated calcium or cholesterol.

A new system of classification is proposed based on physiologic features in which the pathologic feature fits harmoniously into the bacteriologic, chemical and clinical picture.

# ESSENTIAL HYPERHIDROSIS CURED BY SYMPATHETIC GANGLIONECTOMY AND TRUNK RESECTION

ALFRED W. ADSON, M.D.
WINCHELL McK. CRAIG, M.D.
AND
GEORGE E. BROWN, M.D.
ROCHESTER, MINN.

Essential hyperhidrosis is excessive sweating which is limited to circumscribed bilaterally symmetrical areas and to extremities. Excessive sweating of the hands and feet frequently accompanies vasospastic conditions, such as are seen in Raynaud's disease and peripheral atrophic arthritis, but in true essential hyperhidrosis the patient complains chiefly of excessive perspiration that is aggravated by exposure to warm temperatures, by nervous excitement and by emotional strain. This symptom becomes so annoying as to interfere with business and social activities. When the hands are involved, the patients find it impossible to work as bookkeepers or accountants or to work with delicate fabrics that require dry finger-tips. The skin over the finger-tips often becomes macerated and tender. The patients are likewise constantly embarrassed in meeting strangers, since their hands are always dripping wet and they feel compelled to apologize in offering them in the customary salutation. They frequently shun the opposite sex to avoid embarrassing situations. The constantly wet hands soil gloves and ruin fine dress fabrics.

## ANATOMY

The secretory nerve fibers to the sweat glands originate in the thoracicolumbar portion of the sympathetic system. The terminal neuron to a sweat gland is a postganglionic gray ramus that leaves one of the ganglions in the thoracicolumbar chain to reenter the spinal nerve, there to be distributed to the corresponding dermatome of the musculocutaneous segment. This fiber is so intimately entwined with the corresponding sympathetic fibers to the sebaceous glands, pilomotor muscles, arterioles and capillary system of the same segment that it is impossible to separate it from these accompanying fibers. Therefore, any interruption of sympathetic trunks or rami that will produce a vasodilatation of arterioles and capillaries will produce loss of sweating, reduction in sebaceous secretion and paralysis of pilomotor muscles.

---

From the Section on Neurologic Surgery and the Division of Medicine, the Mayo Clinic.

Read at the meeting of the Western Surgical Association, St. Louis, Dec. 7 and 8, 1934.

## PHYSIOLOGY

Sweating and vasodilatation are physiologic responses to the central heat-regulating mechanism. Excessive bodily heat can be reduced by vasodilatation of the arteries and capillaries of the skin and by sweating, as vasodilatation allows more blood to flow to the surface of the body and the evaporation of sweat cools the surface of the skin, both of which lower the temperature of the blood before it completes its arterial circuit.

Because the sympathetic fibers to the peripheral arterial system and those to the sweat glands are so intimately associated and because the two structures appear to have one primary function of regulating bodily temperature, it is only natural that dysfunction of one would bring about an accompanying dysfunction of the other. Therefore, one is not surprised to find the skin of the hands and feet soaked with sweat in cases in which patients suffer from Raynaud's disease. Excessive perspiration does not accompany the stage of blanching but accompanies the partial compensatory phase following asphyxia.

Sweating, though a normal physiologic response, varies with each person. It is normally more excessive among obese persons and those who are excessive eaters, since more heat is generated by the increased metabolism. The excessive sweating of patients with hyperthyroidism is explained on a similar basis. The activity of the sweat glands varies also in the individual case, since some persons perspire more profusely on the face than on the body or feet.

## PATHOLOGY

Excessive sweating is not considered a pathologic symptom unless it interferes with business and social activities. When it accompanies vasomotor disturbances, such as Raynaud's disease, it is promptly relieved when successful sympathetic ganglionectomy and trunk resection are performed to relieve the vasomotor spasm, and it therefore needs no special consideration. Excessive perspiration of the feet is a rather common phenomenon, but rarely is it so severe as to require surgical treatment. When excessive sweating of the feet is accompanied by unpleasant odors (bromidrosis), patients frequently seek relief, and Waring [1] has found the following preparation a useful dusting powder:

| | |
|---|---|
| Pulvis acidi salcylici | |
| Pulvis zinci carbonatis praecepitati | |
| Pulvis magnesii ustae āā | 4 drachms (7.09 Gm.) |
| Pulvis amyli | 15 drachms (26.6 Gm.) |
| Pulvis talcis | 20 drachms (35.4 Gm.) |

1. Waring, J. B. H.: Hyperhidrosis, Virginia M. Monthly **58**:250 (July) 1931.

He suggested that this be used following frequent changes of the hose and after washing the feet. When this fails to produce the desired results, operation on the sympathetic nervous system is indicated (fig. 1).

As has been stated, essential hyperhidrosis is a syndrome characterized by excessive sweating in circumscribed bilateral areas and in the extremities of persons who do not complain of peripheral vascular disease.

## ETIOLOGY

It is rather difficult to offer an adequate explanation for the appearance of essential hyperhidrosis. Pieri [2] classified hyperhidrosis, in the

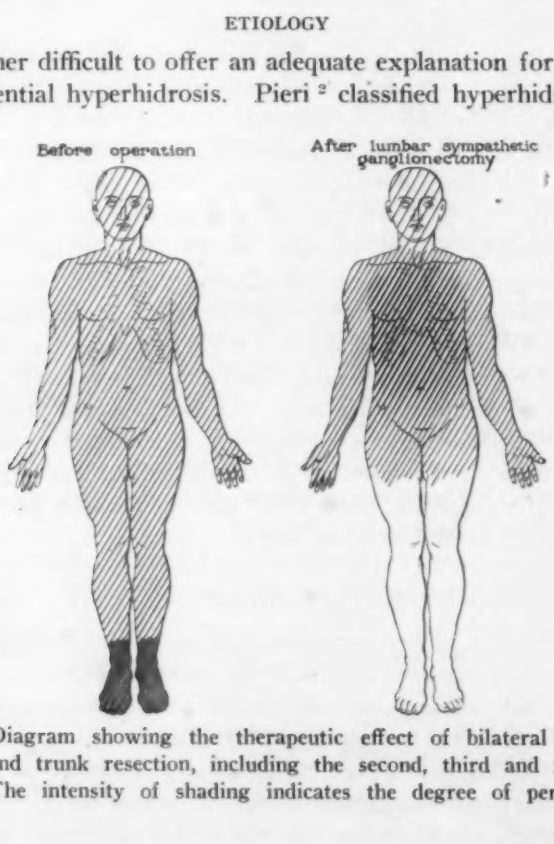


Fig. 1.—Diagram showing the therapeutic effect of bilateral lumbar sympathectomy and trunk resection, including the second, third and fourth lumbar ganglions. The intensity of shading indicates the degree of perspiration that occurred.

report of his five cases, into three types. The first type he referred to as sympathetic hyperhidrosis, occurring secondary to involvement of other organs and resulting from dysfunction of the nervous system. The second type he referred to as functional hyperhidrosis, which is an exaggeration of the normal sweating function. The third type he called idiopathic hyperhidrosis and included cases in which he has been unable to establish the origin of the hyperhidrosis.

2. Pieri, Gino: Contributi alla chirurgia del sistema nervoso vegetativo; la cura della iperidrosi, Arch. ital. di chir. **31**:117 (Feb.) 1932.

Roberts,[3] in an ably presented review of a case of hyperhidrosis and cyanosis which was relieved by sympathectomy, stated that the responsibility for the morbid condition lay not in the central nervous system but in the mesenchymal cells that surround the capillaries of the derma. Roberts further expressed the belief that these pericapillary zones are physiologically distinct from the differentiated parts of the derma, and he agreed with authorities who ascribed to the undifferentiated cells of these zones peculiar properties; not only are they the mother cells, out of which are derived the endothelial cells, but they control the behavior of the capillaries, causing their expansion or contraction and maintaining the general tone of the capillary bed. He expressed the opinion that this control is chemical or physicochemical rather than nervous and that the nerve impulse is merely the trigger that starts the dermal reactions.

Functional hyperhidrosis of Pieri consists of excessive normal sweat responses. We suspect that Pieri included in this group of patients with sympathetic hyperhidrosis those who had excessive sweating accompanying vasomotor diseases such as Raynaud's disease. Judging from Roberts' review, it appears that his case would fall in the same group as does the case reported by Leriche and others[4] and cases of ours in which patients sought relief primarily for the symptoms of Raynaud's disease or the pains of atrophic polyarthritis of the hands and feet. Roberts' explanation of the phenomenon of excessive hyperhidrosis in these cases of sympathetic hyperhidrosis corresponds in a general way with the explanation offered by those who believe that Raynaud's disease is the result of a peculiar property inherent in the mesenchymal cells or the dermal arteries. However, the other school of thought still holds that the nervous control plays a more important part than mere trigger function, since interruption of this nervous control by sympathetic ganglionectomy and trunk resection completely abolishes the function of sweating in the somatic segment thus innervated. Increased temperature, nervous excitement and emotional strain no longer are capable of producing sweating in the denervated somatic segment. If sweating and vasomotor control were governed by the peculiar properties of these mesenchymal cells, one would expect a certain degree of sweating to continue when the patient encountered stimuli that produced sweating before operation.

---

3. Roberts, H. L.: The Removal of the Inferior Cervical Ganglia and Its Effect on Hyperhidrosis and Cyanosis of the Hands and Feet, Brit. J. Dermat. **46**:126 (March) 1934.

4. (*a*) Leriche, R., and Arnulf, G.: Effets de diverses sympathectomies sur la sudation, Bull. et mém. Soc. nat. de chir. **60**:354 (March 3) 1934. (*b*) Leriche, R., and Frieh, P.: Hyperhydrose extrêmement prononcée des mains et des pieds: Essai de traitement par des opérations sympathiques, Lyon chir. **31**:86 (Jan.-Feb.) 1934.

To substantiate further the proof that sweating is a response to the central heat-regulating mechanism and is controlled by central influence, we refer to cases in which patients underwent sympathectomy and in which it was observed that the amount of sweat secreted was greatly increased in areas of skin not affected by the operation. This excessive secretion of sweat between the areas deprived of sympathetic innervation, we believe, represents an increased response to the normally innervated area from the heat-regulating center, in order to maintain

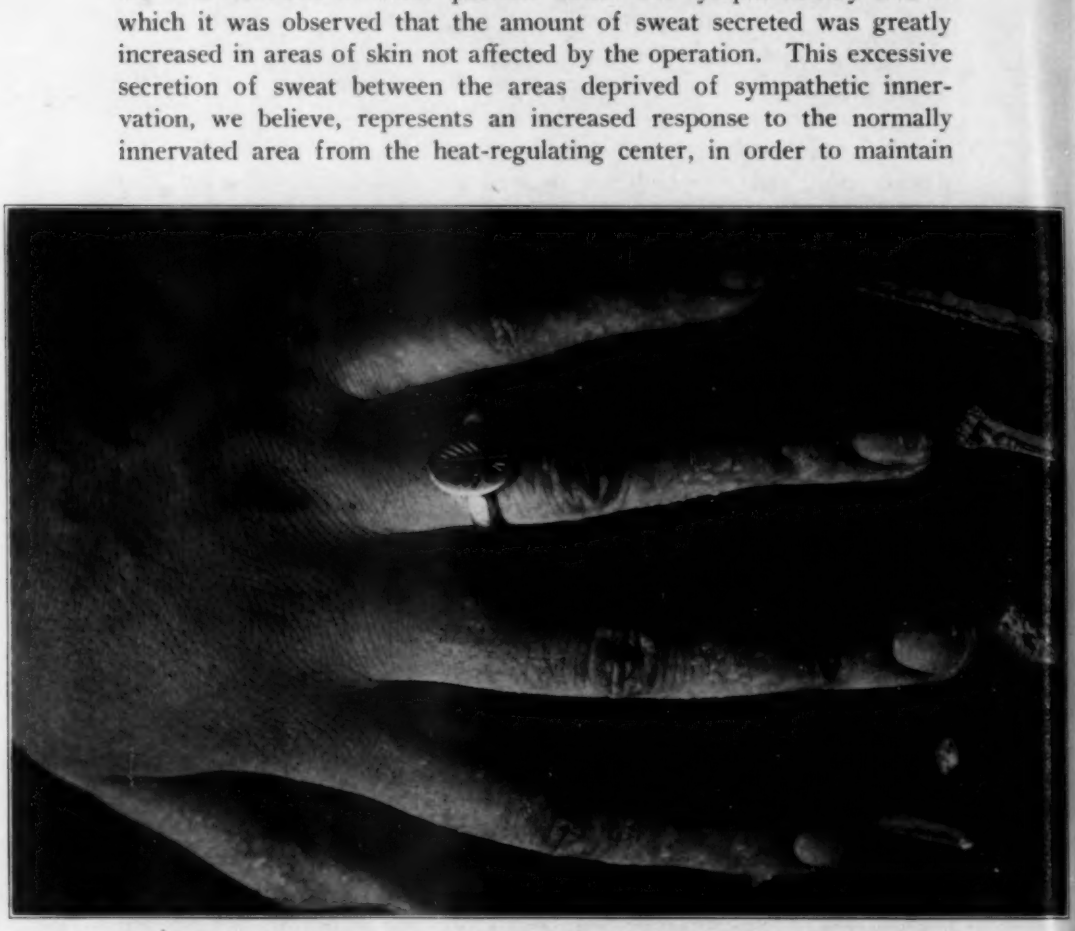

Fig. 2.—The degree of excessive sweating is illustrated by the appearance of droplets on the fingers and streams of perspiration running from the finger-tips during the interval while the photograph was taken.

normal bodily temperature. Though the sweat contains waste products, it does not mean that the body is dependent on this secretion for elimination when the kidneys still function normally.

For the idiopathic type we suggest the name "essential hyperhidrosis," and we include in this type the condition presented by patients who complain chiefly of excessive sweating that interferes with their work and social activities (figs. 2 and 3). We further believe that this type of hyperhidrosis results from dysfunction of the sympathetic nervous system, a dysfunction not unlike that of Raynaud's disease,

which originates in the higher cerebral centers, and that the act of sweating is only a response to a central stimulus.

## TESTS FOR SWEATING

The routine procedure consists of placing the patient in a warming chamber and exposing the entire nude body to an environmental temperature of approximately 120 F. The intensity and distribution of the sweating are noted and quantitated. After operation similar studies are carried out, using test papers of cobalt blue. These are placed on the skin of the face, neck, thorax, arms and fingers following cervicothoracic operation. To test the completeness of lumbar ganglionectomy, test papers are placed on the skin of the lower part of the abdomen and on the legs and toes. The blue color of the testing paper changes to pink

Fig. 3.—Hyperhidrosis of the toes and foot.

in the presence of slight degrees of sweating. This outlines the thoroughness and the extent of the sympathectomy.

Another method of testing is accomplished by the administration of pilocarpine in doses of 1/10 grain (0.006 Gm.) and indicates the functional activity of the sweat glands. This drug acts directly on the sweat glands. Tests carried out within one month after operation usually show that sweating can be induced by this drug. Months after the operation, the peripheral effects of pilocarpine gradually diminish and sweating is entirely absent.

## REPORT OF CASES

CASE 1.—A man,[5] aged 27 years, a clerk for an oil company, complained of excessive sweating of the palmar surfaces of both hands and the solar surfaces of

5. Adson, A. W., and Brown, G. E.: Extreme Hyperhidrosis of the Hands and Feet Treated by Sympathetic Ganglionectomy, Proc. Staff Meet., Mayo Clin. **7**:394 (July 6) 1932.

the feet of seven years' duration. Sweating was more marked in the summer and in heated rooms during the winter. During the summer the hands became excessively wet, and the constant sponging necessary caused desquamation of the outer layers of the skin. Fissures developed between the finger folds, and it was practically impossible to use the fingers because of the burning and distress of the desquamated skin. Each year the condition had become worse, and this made the patient exceedingly nervous and irritable.

The patient was examined on a moderately warm day, at which time the hands were wet to a rather abrupt line at the wrist and the feet to the level of the malleoli. The hands and feet were slightly puffed, and the skin on the palms was slightly denuded. Sweating of the feet had not started until sweating of the hands became marked. Various known medical measures had been tried for five years

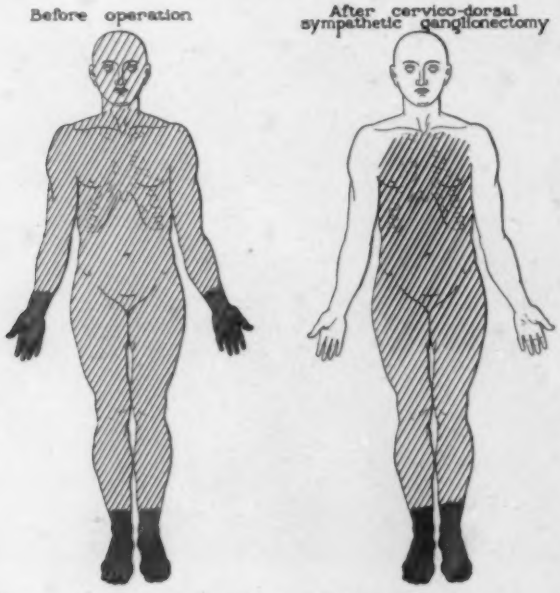


Fig. 4.—The intensity of shading illustrates the degree of perspiration that occurred before the operation, and the absence of shading over the face, neck, arms and hands illustrates the therapeutic effects of sympathectomy.

previously but without avail. The patient was greatly depressed mentally during the summer months, and he faced the hot weather with dread. The condition constituted a true disability, and the patient insisted that measures be taken to control it as it was seriously interfering with his livelihood.

General examination gave normal results. The diagnosis in this case was hyperhidrosis of the hands and feet. The condition was bilateral and symmetrical on the four extremities. The distribution and mode of onset strongly suggested a primary disturbance of the cerebral sympathetic center, since such limited areas were involved.

Bilateral cervicothoracic ganglionectomy and trunk resection by the posterior approach was performed on June 17, 1932. All communicating rami, with the brachial nerves, were interrupted in addition to resection of the trunk and ganglions. The patient's recovery was uneventful. The hands were perfectly dry following operation (fig. 4).

Sweating tests were carried out fourteen days after operation in a heat chamber (120 F.), strips of cobalt blue paper being used as indicators for minimal degrees of sweating. There was complete absence of sweat on the upper part of the thorax, head, arms and hands. Sweating of the dorsal surfaces of the feet was profuse; of the plantar surfaces, mild. There was sweating in all areas following administration of 1/10 grain (0.006 Gm.) of pilocarpine. The average surface temperatures of the fingers increased 1 C., and Horner's syndrome was complete and equal on the two sides. The patient's general condition was excellent, and improvement in his mental condition was striking. The surgical result has continued to remain successful.

CASE 2.—A girl, aged 18, for the past thirteen years had suffered from excessive sweating of the hands and, to a lesser degree, of the feet. This had begun

Fig. 5.—Maceration of skin on the palmar surface of fingers and palm from excessive sweating, as well as the degree of hyperhidrosis indicated by streams of sweat leaving the fingers during the interval of time required to make the photograph, may be noted.

following mastoidectomy on the right side. The feet and hands were objectively cold most of the time, and at times the hands revealed small red papules; in winter they cracked and became painful. She had suffered from headaches for the past three or four years, and these had occurred almost daily; they were relieved by acetylsalicylic acid. Her hands perspired practically all the time; they were especially affected when she was nervous about meeting people. In hot weather spontaneous attacks had occurred.

The patient's blood pressure in millimeters of mercury was 114 systolic and 76 diastolic. General examination otherwise gave normal results. A diagnosis of

essential hyperhidrosis was made, and operation was carried out on Nov. 14, 1933, at which time bilateral cervicothoracic sympathetic ganglionectomy was performed. The wound healed by primary intention. Convalescence was uneventful except for the complaint of pains in the arms and shoulders. The patient's hands were warm and dry at the time of her dismissal. In a letter written in June 1934 she stated that she was completely relieved of hyperhidrosis and was enjoying life as never before (figs. 5 and 6).

CASE 3.—A man, aged 35 years, complained of excessive sweating of the hands, which he had noted since childhood. This condition was noticeably worse when he became excited. He had also noticed cracking and burning of the hands. His feet were cold but did not perspire excessively. He was a very ambitious, energetic type of man and had entered an engineering school; however, because

Fig. 6.—The effect of cervicothoracic sympathetic ganglionectomy and trunk resection in preventing excessive perspiration and in restoring the condition of the skin of the patient's hands illustrated in figure 5.

of the excessive sweating of his hands, he was unable to finish his course in draftsmanship, and consequently he was forced to leave school. He became an automobile salesman but found it exceedingly difficut to write letters or to sign checks on account of this excessive perspiration.

General examination gave normal results except for mild hypertension, the blood pressure in millimeters of mercury being 140 systolic and 90 diastolic. A diagnosis of excessive hyperhidrosis of both hands was made, and on Nov. 3, 1933, bilateral cervicothoracic sympathetic ganglionectomy was performed. Following operation, the wound healed by primary intention, convalescence was uneventful, and there was complete cessation of sweating of the hands. The patient returned home completely relieved. Ten months after taking a 3,000 mile automobile trip, he stated that his hands were completely free from excessive perspiration and that his general condition was excellent. He is one of the most grateful patients we have ever had.

CASE 4.—A man, aged 25 years, registered at the clinic on Feb. 28, 1934, complaining of excessive sweating of the feet and hands. When he was about 8 or 9 years of age he had noticed that after a few minutes' exposure of his face to cold his cheeks would turn red, purple and white and would begin to swell. When he returned to a warm room this condition would be entirely relieved. At about the age of 12 years he began to notice excessive sweating of the hands and feet. At the age of 18 he began to have sick headaches on one or the other side of his head. They were worse in hot weather and could be brought on by a jar. He had scotoma and nausea but no vomiting. Gradually developing throughout this course he had had increasing nervousness and fatigue.

General and neurologic examinations revealed no organic lesions except for a blood pressure in millimeters of mercury of 140 systolic and 85 diastolic. Dr. E. V. Allen, consulting internist, made the following note summarizing the report of the examination: "The syndrome is 'sympatheticotonia' expressed by nervousness, hyperhidrosis, a tendency to hypertension, palpitation and vascular instability. The patient has migraine, exhaustion, cold wet hands and feet, vasomotor changes in the hands, pallor and swelling on exposure of the face to cold and vasomotor rhinitis and duodenitis."

Bilateral cervicothoracic sympathetic ganglionectomy was done on March 8, 1934. The patient's postoperative course was uneventful, and the wound healed by primary intention. Immediately following the operation the hands were warm and dry.

In a letter written on Nov. 20, 1934, the patient stated that he had been free from sweating of the hands, arms and head but had had more than usual on his back. Headache and migraine had disappeared, except for a slight ache back of his eyes which lasted only thirty minutes and occurred only at night. He still complained of nervousness, fatigue, redness of the eyes on waking and rhinitis.

CASE 5.—A South American man, aged 22, complained of excessive sweating of the hands and of burning gastric pains. General examination revealed no evidence of organic gastric disease. Hyperhidrosis of the hands had been gradually progressive for a number of years. The condition was much worse in hot weather and was aggravated by nervousness. In view of the fact that he was an engineering student, excessive perspiration of the hands interfered to a great extent with his work on books and paper. The skin on the palmar surfaces was wet, soft, mushy and red. Beads of sweat stood out in droplets on this palmar surface. The patient's feet were slightly affected, but not nearly so severely as his hands.

Bilateral cervicothoracic sympathetic ganglionectomy was performed on August 30, 1934. During his convalescence the patient complained of Horner's syndrome and of pain in the ulnar aspect of each arm. The wound healed by primary union. The aching pains in the arms disappeared in three weeks, although Horner's syndrome will continue permanently. He became accustomed to it and did not complain further when he learned that his vision was not impaired. His hands promptly became dry following the operation, which he stated more than compensated for the pain he suffered.

The review of these five cases reveals that the chief symptom was that of hyperhidrosis which affected the hands and fingers. Four men and one woman had this symptom; all of them were of the asthenic type, and none of them complained of cyanosis of the fingers. All of them, however, had vasomotor instability in that their hands were either hotter or colder than the examiner's hand. In most instances the skin

on the palmar surface was bright pink or almost red. Patients with this condition, as is also the case with patients who have Raynaud's disease, frequently exhibit other disturbances of the autonomic nervous system. Functional disorders of the gastro-intestinal tract, fatigued states, vasomotor rhinitis and vasomotor instability with poor adaptation to environment are common expressions of sympathetic imbalance. The primary abnormality suggests an origin in the central nervous system. This conception is strengthened by observations recently made in two cases. In one case [6] a boy for ten years during his waking hours exhibited a rhythmic fall in bodily temperature to levels as low as 91 F. This

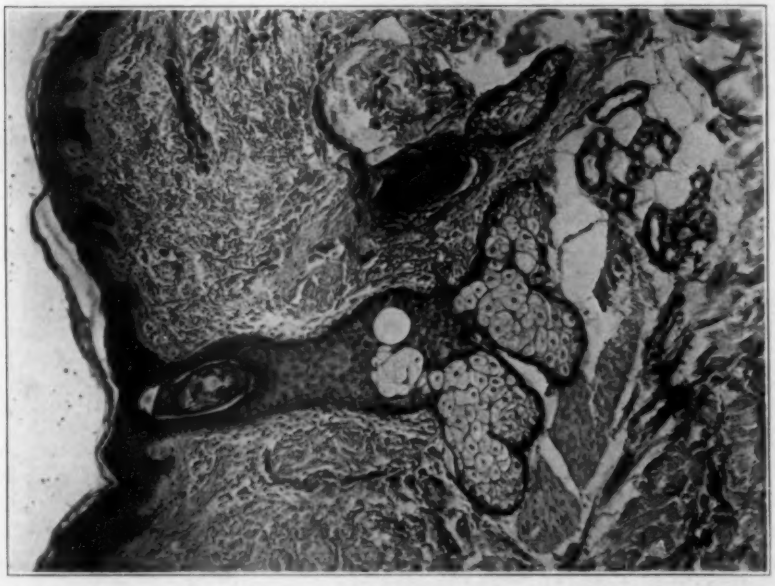

Fig. 7.—Appearance of skin, hair follicle and sebaceous and sweat glands taken from the forearm of a patient who had undergone cervicothoracic sympathetic ganglionectomy for Raynaud's disease fifteen months prior to the biopsy (× 75).

periodic hypothermia was associated with profuse generalized hyperhidrosis. The probable etiologic factor in this case was encephalitis, which had affected both the temperature and the sweating centers. Control of sweating did not modify the hypothermia, but when amytal was given, or when the patient was asleep, the central irritability was controlled, with return of temperature to normal levels and disappearance of hyperhidrosis. A second patient, a boy with anhidrosis, presented features of erythromelalgia. The extremities were hot and painful

6. Hines, E. A., Jr., and Bannick, E. G.: Intermittent Hypothermia with Disabling Hyperhidrosis: Report of a Case with Successful Treatment, Proc. Staff Meet., Mayo Clin. **9**:705 (Nov. 21) 1934.

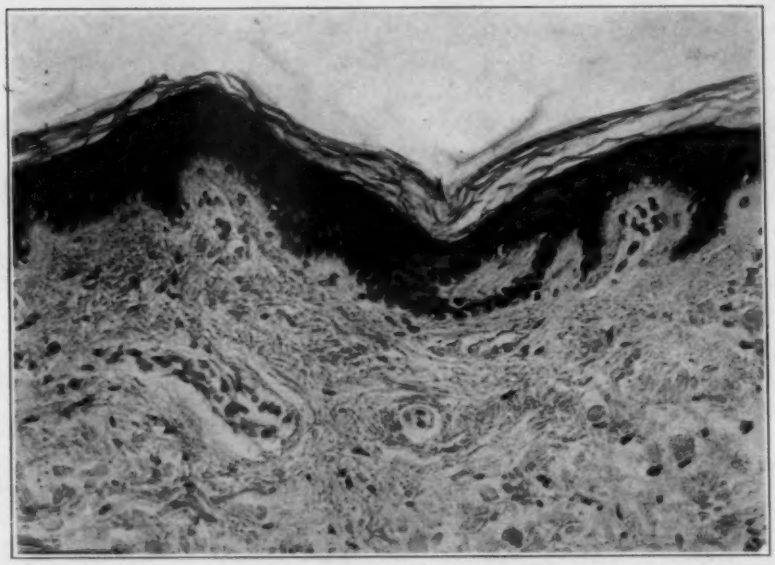

Fig. 8.—Higher magnification of figure 7, illustrating slight increase in fibrous tissue with no other change (× 175).

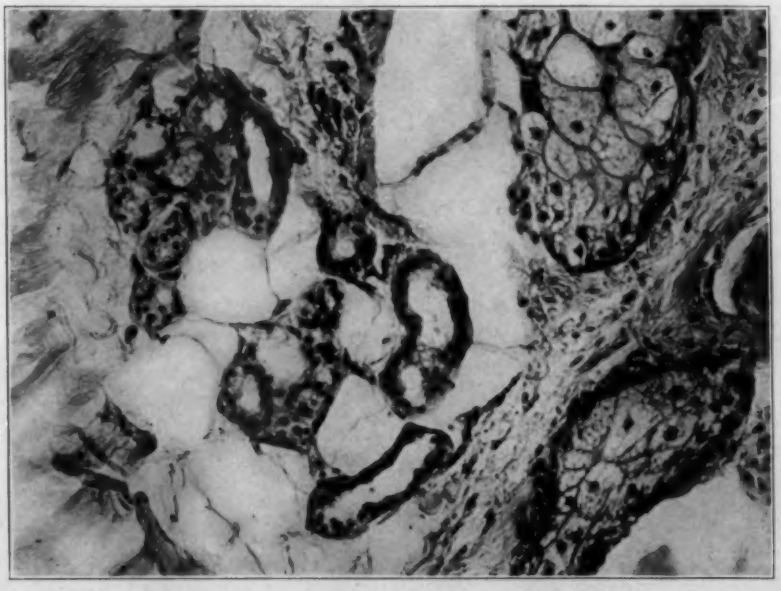

Fig. 9.—Higher magnification of sebaceous and sweat glands in figure 7, revealing no atrophy or change from the normal although a successful interruption of postganglionic rami has been effected by cervicothoracic sympathetic ganglionectomy.

when exposed to room temperatures. The absence of heat radiation from the lack of sweating created local areas of hyperthermia, with distressing, disabling symptoms. The etiology of this disease was not clear, but there was a suspicion that a cerebral disease had affected the sweating centers (hypothetic); at least, there was no evidence that any peripheral dysfunction was the primary disorder.

The cures effected by removal of the sympathetic control in cases of Raynaud's disease and of localized forms of hyperhidrosis furnish strong evidence of an abnormality referable to the central nervous system in these disorders (figs. 7, 8, 9 and table).

*Hyperhidrosis: Surface Temperatures (Degrees, C.)* *

| Case | Operation | Digits | | | | | | Comment |
|---|---|---|---|---|---|---|---|---|
| | | $R_1$ | $R_3$ | $R_5$ | $L_1$ | $L_3$ | $L_5$ | |
| 1 | Before | 28.4 | 28.5 | 28.7 | 29.0 | 29.2 | 28.7 | Complete |
| | After | 35.7 | 35.8 | 35.7 | 35.8 | 36.0 | 35.7 | operation |
| 2 | Before† | .... | .... | .... | .... | .... | .... | Complete |
| | After | 35.3 | 34.1 | 34.5 | 35.3 | 35.4 | 35.7 | operation |
| 3 | Before† | .... | .... | .... | .... | .... | .... | Complete |
| | After | 33.4 | 34.6 | 34.5 | 34.3 | 34.7 | 34.6 | operation |

* Readings of surface temperatures were taken with an electrothermocouple from the skin over the first, third and fifth fingers of each hand, before and after the completion of cervicothoracic sympathetic ganglionectomy and trunk resection. R indicates right; L, left.
† No readings obtained before operation.

## SUMMARY

Essential hyperhidrosis affecting the hands and feet is frequently a most disabling disease and seriously interferes with the patient's ability to earn a livelihood. Observations indicate that the severity of the condition and the areas involved by the excessive sweating are controlled by a cerebral influence. Complete cure is effected by sympathetic ganglionectomy.

# OSGOOD–SCHLATTER'S DISEASE

CHARLES J. SUTRO, M.D.*
AND
M. M. POMERANZ, M.D.
NEW YORK

In the diagnosis of Osgood-Schlatter's disease both clinical and roentgenographic features must be evaluated. The information revealed by roentgenograms is often clearcut and convincing. However, it seems that anatomic variations in the tibial tubercle are too often regarded as pathologic.[1] On reviewing the roentgenograms of several hundred knee joints of children, adolescents and young adults who had no clinical complaints referable to this region, we observed variations in the size, shape and manner of growth of the tubercle. Furthermore, it is important to remember that no unusual thickening of the attachment of the patellar ligament into the tibial tubercle is observed roentgenographically (fig. 1*A* and *B*). With these safeguards in mind, we attempted to establish the criteria by which roentgenographic diagnosis of Osgood-Schlatter's disease can unequivocally be made, so that anatomic variations will not be misinterpreted.

We found on examining the roentgenograms made in 106 cases[2] of Osgood-Schlatter's disease that thickening of the patellar ligament at

---

* Brown Orthopedic Research Fellow.

From the Department of Radiology and the Department of Pathology of the Hospital for Joint Diseases.

1. Palugyay, J.: Fortschr. a. d. Geb. d. Röntgenstrahlen **35**:595 (Jan.) 1927.

2. These 106 cases from the orthopedic services are from a group of 120 in which the diagnosis was Osgood-Schlatter's disease, 14 of which were not considered instances of this condition after restudy. In this group of 106 cases, the right knee was involved in 40, the left knee in 48 and both knees in 18. Ninety-nine of the patients were males. Ten were adults varying in age from 21 to 45 years who presented islands of bone (roentgenographic picture) in the patellar ligament, with occasional symptoms of pain and swelling about the tibial tubercle (nonhealed type of Osgood-Schlatter's disease). The remaining 96 patients were divided into the following age groups:

| Age | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 years |
|---|---|---|---|---|---|---|---|---|---|---|
| Male | 2 | 1 | 10 | 14 | 30 | 26 | 4 | 3 | .. | 1 |
| Female | 1 | 1 | 1 | 1 | 1 | | | | | |

In this group of 106 patients, 40 per cent cited trauma as relevant to the presenting symptoms, 25 per cent were not certain of any preexisting trauma, and 35 per cent gave no evidence of any trauma.

its insertion was a fairly constant if not an invariable sign of disease in that region (fig. 1*C*). In fact, such a swelling was occasionally observed roentgenographically even prior to the finding clinically of a mass of soft tissue in the region of the tubercle (fig. 2*A*). Next in importance is the presence of irregular calcific spicules radiating from the anterior surface of the tubercle (fig. 2*B*). As the lesion progresses they may extend for some distance into the patellar ligament. Furthermore, small or large fragments of bone avulsed from the anterior surface of the tubercle were also to be found in the patellar ligament (fig. 2*C*). Islands of bone were seen in the patellar ligament at a considerable distance above the lowest point of the tibial tubercle (fig. 3*A*). These may have

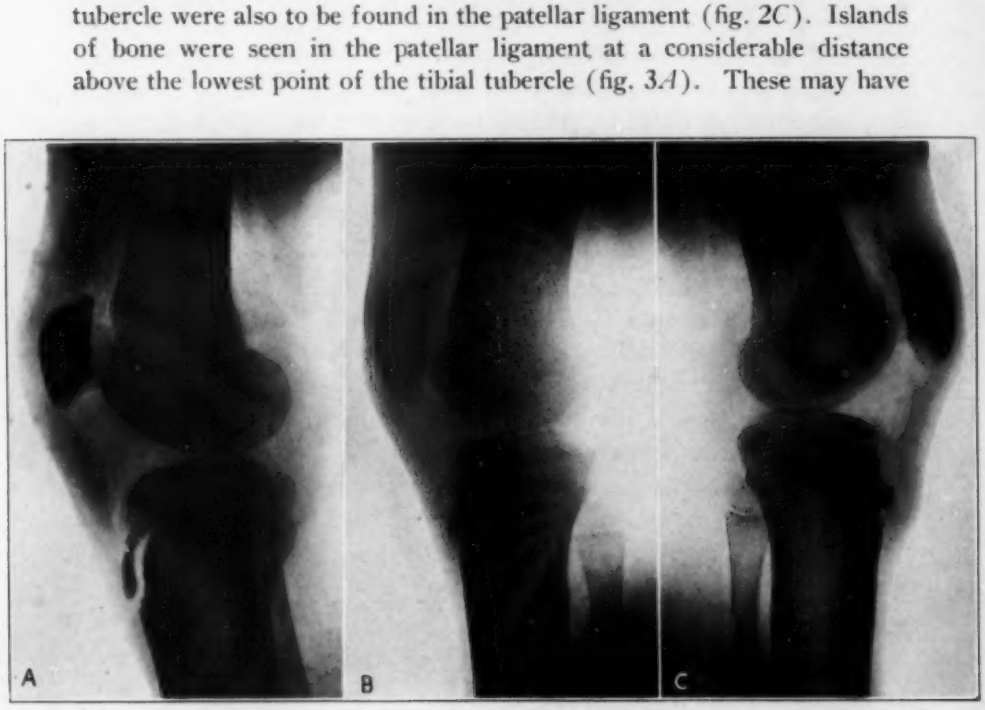


Fig. 1.—*A*, a roentgenogram of the right knee of a boy 13 years old which shows defects in the tibial tubercle. The absence of soft tissue swelling in this region precludes a diagnosis of Osgood-Schlatter's disease. Note that all the photographs of the roentgenograms are reproduced dark in order to show clearly the soft tissues. *B*, a roentgenogram of the right knee of a boy 13 years old which shows a separate center of ossification; no soft tissue swelling is noted. *C*, a roentgenogram of the left knee of the same boy (fig. 1 *B*) reveals a separate center of ossification for the tubercle with a definite soft tissue swelling. The diagnosis was Osgood-Schlatter's disease.

formed there or may have been fragments which were avulsed from the tubercle. In most of our cases the epiphyseal plate between the tubercle and the tibial metaphysis was not unusually widened. In some the distal tip of the tubercle pointed toward the region of the knee joint.

Clinically, most of our 106 patients with Osgood-Schlatter's disease complained either of constant or of intermittent pain, or of discomfort about the knee. They frequently were aware of a mass in the region of the tibial tubercle. Clinical examination revealed soft tissue swellings in the region of the tibial tubercle in about 90 per cent of our patients. In several instances, in spite of advanced roentgenographic changes in the tibial tubercle no localized tenderness was noted. Motions of the knee were free. In many patients flexion of the knee caused tenderness over the tibial tubercle.

The review of our roentgenograms showed the pathologic changes of Osgood-Schlatter's disease to occur in the vicinity of the insertion of

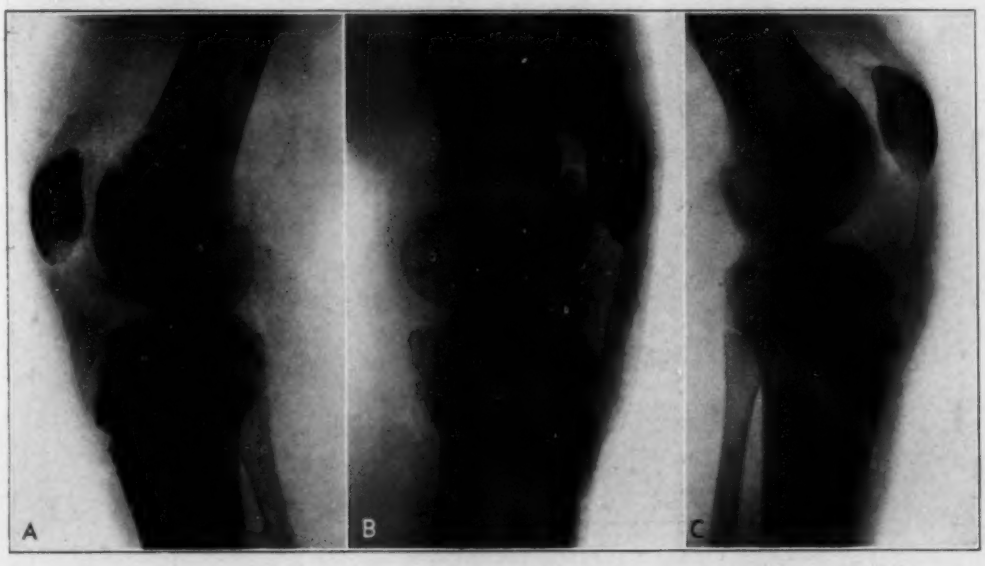


Fig. 2.—*A*, a roentgenogram of the right knee which shows an island of bone in the thickened patellar ligament. There is no definite subcutaneous swelling. The diagnosis was Osgood-Schlatter's disease. *B*, a roentgenogram of the left knee which reveals calcific spicules on the anterior surface of the tibial tubercle. Note the swelling of the patellar ligament. *C*, a roentgenogram of the left knee which demonstrates an island of bone in the thickened patellar ligament. The diagnosis was Osgood-Schlatter's disease.

the patellar ligament into the tubercle and in the anterior portion of this bone. Few abnormal roentgenographic manifestations were seen in the radiotranslucent zone between the tubercle and the tibia, on the posterior surface of the tubercle and on the anterior cortex of the tibial metaphysis.

The cause is still unsettled in spite of the many reported pathologic studies.[3] There is good reason to believe, however, that traction of the patellar ligament has some influence on the development of this condition. Excessive or abnormal traction, such as may occur in very active boys, may produce a slow-forming proliferative lesion (calcification or ossification) at the site of the insertion of the patellar ligament. Degeneration or tearing of the patellar ligament at its insertion is probably the earliest lesion. This may be comparable to the changes leading to the production of painful swellings at the region of the insertion of the posterior tibial tendon into an accessory scaphoid.[4]

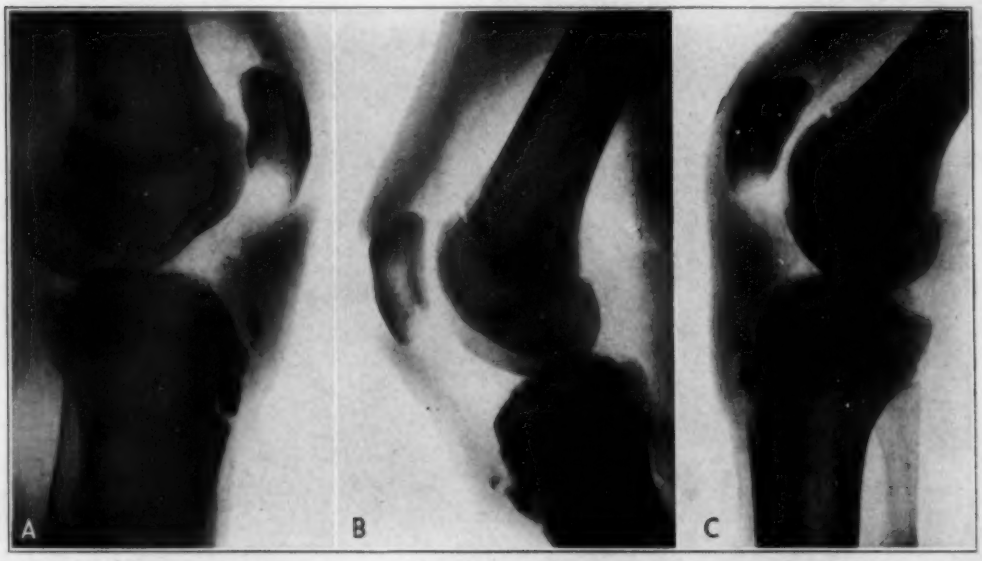


Fig. 3.—*A*, a roentgenogram of the left knee of a boy 14 years old which shows a large and small island of bone in the thickened patellar ligament. The diagnosis was Osgood-Schlatter's disease. *B*, a roentgenogram of the right knee in a case in which the diagnosis was Osgood-Schlatter's disease. *C*, a roentgenogram of the same knee taken six weeks after drilling of the tibial tubercle. Note especially the increase in bone formation on the anterior surface of the tubercle as well as the persistent soft tissue swelling.

3. Anardi, T.: Chir. d. org. di movimento **12**:187 (March) 1928. Guiliani, G.: ibid. **14**:243 (Oct.) 1929; **17**:105 (June) 1932. Stracker, O.: Ztschr. f. orthop. Chir. **58**:242, 1932. Horbst, L.: Arch. f. orthop. u. Unfall-Chir. **33**:229, 1933. Block, W.: Arch. f. klin. Chir. **174**:172, 1933.

4. Similar pathologic changes (degeneration, fibrillation, vascularization, calcification and ossification) of the supraspinatous tendon at its insertion to the greater tuberosity of the humerus have been described.

There is clinical evidence that physical activity plays a good part in the development of the lesion, as noted by its greater frequency in boys. A higher incidence of Osgood-Schlatter's disease has been noted among the Japanese, possibly because of their habit of kneeling.[5] Similarly, a relative higher percentage of involvement of the tibial tubercle has been reported among the younger inhabitants of Switzerland, where mountain climbing is a fairly common sport.[6] It is of interest that combined lesions of Osgood-Sclatter's disease and bipartite patella have been recognized. That these may be due to traction of the patellar ligament may be surmised from the occurrence of either bipartite or high patellae in subjects with Little's disease.[7]

There is no definite clinical or pathologic basis on which to consider Osgood-Schlatter's disease the result of rickets, syphilis, so-called osteochondritis, infection or some disturbance of the endocrine system.[8] It is true, however, that in the patient with the last mentioned disease, because of obesity there may be more stress and strain on the patellar ligament which secondarily makes him more susceptible. Eight patients in our group presented Fröhlich's syndrome.

As for therapy, it seems that when operative treatment is suggested removal of the tubercle is advisable. Procedures less radical, such as drilling or bone pegging, in an attempt to fuse the epiphyseal plate between the tubercle and the tibia[9] may aggravate rather than relieve the pathologic condition of the patellar ligament (fig. 3*B* and *C*). It appears, however, that there is a good deal in favor of conservative

5. Asada, T., and Kato, S.: Ztschr. f. orthop. Chir. **48**:191 (April) 1927.

6. von Brandis, H. J.: Ztschr. f. orthop. Chir. **48**:239 (April) 1927.

7. Delitala, F.: Chir. d. org. di movimento **9**:293 (March) 1925. Ratto, O. J., and Casanovas, L. O.: Prensa méd. argent. **15**:106 (June 20) 1928. Serfaty, M., and Marottoli, O. R.: ibid. **15**:1030 (Jan. 30) 1929. Dueño, F. P.: Rev. de cir. de Barcelona **4**:137 (Sept.) 1932.

8. Paget, James: Selected Essays and Addresses, London, Longmans, Green & Co., 1902. Osgood, R. B.: Boston M. & S. J. **148**:114, 1933. Schlatter, C.: Beitr. z. klin. Chir. **38**:874, 1903; **59**:518, 1908. Jakobsthal, H.: Deutsche Ztschr. f. Chir. **86**:493, 1906. Alsberg, A.: Ztschr. f. orthop. Chir. **20**:302, 1908. Licini, C.: Beitr. z. klin. Chir. **78**:394, 1912. Stephens, R.: Ann. Surg. **73**:77 (Jan.) 1921. Graef, W.: Beitr. z. klin. Chir. **95**:647, 1915. Soule, R. E.: J. Orthop. Surg. **3**:550 (Oct.) 1921. Davis, G. G.: Internat. Clin. **1**:133, 1921. Rieder, W.: Arch. f. klin. Chir. **120**:588, 1922. Mandl, F.: Beitr. z. klin. Chir. **126**:707, 1922. Bader, E. R.: Am. J. Roentgenol. **9**:623 (Oct.) 1922. Hartley, J. N. J.: Edinburgh M. J. **30**:254 (Sept.) 1923. Fels, E.: Arch. f. klin. Chir. **129**:552, 1924. Pomeranz, M. M.: Am. J. Surg. **39**:17 (Feb.) 1925. Grossman, J.: M. J. & Rec. **121**:534 (May) 1925. Ollerenshaw, R.: Brit. M. J. **2**:944 (Nov. 21) 1925. Van Neck, M.: Arch. franco-belges de chir. **29**:119 (Feb.) 1926. Trinci, U.: Chir. d. org. di movimento **13**:601 (July) 1929. Gioia, T.: Semana méd. **2**:1857, 1929.

9. Pease, C. N.: Am. J. Surg. **24**:149 (April) 1934.

treatment (immobilization of the knee joint), which would relax the patellar ligament. Recurrence of symptoms about the knee in adults similar to those occurring in Osgood-Schlatter's disease may be due to an island of bone in the patellar ligament which has not united with the tibial tubercle. This is the result most likely to occur following Osgood-Schlatter's disease during childhood. In these cases, removal of the osseous island is advisable.

# CONGENITAL MEDIAN CLEFT OF THE CHIN

WILLIAM J. STEWART, M.D.

COLUMBIA, MO.

Clefts of the upper lip and of the hard and soft palates are so common as to be almost routine in any large surgical clinic. Medial clefts of the chin, however, are extremely rare. No mention is made of these in most of the standard textbooks of surgery.

The case reported in this paper is one that came under the care of the State Crippled Children's Service, University Hospitals, Columbia, Mo. A child 3 days old was admitted who had a complete cleft of the lower lip and mandible extending almost down to the cricoid cartilage, with a bifid tongue as a complicating feature.

Etiologically, median clefts of the lower lip represent arrested development due to failure of union of the two inferior portions of the first branchial arch. The clefts may be simple, involving only a portion of the lip, or may extend completely down the midline to include the thorax, as is sometimes seen in cases of monster formation. The same factors which produce the usual clefts of the upper lip and palate are present in the formation of medial clefts of the lower lip and are apparently active in the early weeks of fetal life.

## REPORT OF A CASE

The child was admitted to this service on Jan. 3, 1934, when 3 days old. The extent of the deformity is shown in figure 1. The baby was apparently normal in other respects. The lip was held together with adhesive plaster during the early period in the hospital in order to facilitate feeding, and when the baby was 6 weeks old closure of the lip was done. The tongue was freed from the vermilion border and the body of the lip and the ends of the bifid mandible were then exposed subperiosteally. The lip itself was closed by undermining and freshening the edges of the cleft and approximating the two parts in the midline by the use of horsehair sutures. The edges of the lip were found to be very thin, and owing to this fact the result immediately after operation was not as good cosmetically as was desired. An attempt was made to approximate the ends of the mandible by the use of heavy chromic gut, but in passing the needle through one portion of the mandible two tooth buds were dislodged. In addition to this the child did not appear to be in very good condition, so the bone closure was left for a later date. The child recovered promptly from this procedure and was able to eat better than before operation.

---

From the Department of Orthopedic Surgery, State Crippled Children's Service, University Hospitals.

Fig. 1.—Before operation.

Fig. 2.—Nine and one-half months after closure of the defect. The mandible is still bifid. No attempt will be made to correct this until the permanent teeth erupt.

The patient was readmitted to the hospital on Oct. 17, 1934, when 10 months old, and a revision of the lip was done on October 29 with improvement of the cosmetic aspect of the lip. The chin had begun to fill out and develop. The tongue was still attached between the two portions of the mandible, and the frenum was again freed for about half an inch. Respiration and deglutition were improved following this procedure.

Fig. 3.—The scar is quite wide, and this will require a revision operation some time in the summer.

At this time it was noted that the child was subject to "blue spells" on crying, and it was found that there was a congenital lesion of the heart which had not manifested itself earlier. This lesion has been variously interpreted as a patent ductus arteriosis, patent foramen ovale or an anomaly of the tricuspid valve, but no definite decision as to the type of defect has been reached. Roentgen examination of the chest has never shown any widening of the mediastinum or other evidence of an enlarged thymus. Under anesthesia the child behaved normally, and no difficulties were experienced.

She is now 13½ months old, is able to sit erect and is attempting to stand. No teeth have erupted as yet, but her general condition is satisfactory.

Efforts to close the mandible will be delayed for several years until permanent teeth have erupted so that a suitable retention apparatus can be applied to keep a bone graft in position.

# LATE SUBCUTANEOUS RUPTURE OF THE TENDON OF THE EXTENSOR POLLICIS LONGUS MUSCLE

BENJAMIN LIPSHUTZ, M.D.
PHILADELPHIA

Subcutaneous rupture of the tendinous segment of the extensor pollicis longus muscle as a late complication of a Colles fracture is extremely uncommon. Recently (January 1932) McMaster [1] found only twenty-seven such cases reported in the literature and added an additional case. Included in McMaster's contribution is the only available instance of a rupture of the tendon of the flexor pollicis longus muscle following a Colles fracture. Four cases of late rupture of the extensor pollicis longus tendon are reported by Horwitz [2] from Bier's clinic; two were associated with a Colles fracture, one with fracture of the base of the first metacarpal bone and one with osteitis fibrosa cystica of the styloid process of the radius.

Auxhausen expressed the opinion that rupture of this tendon is not as rare as is generally believed, since he and Hauck observed ten such cases. Platt's [3] experience suggested a similar point of view, for he recorded seven instances of rupture of the extensor pollicis longus tendon, six associated with fracture of the lower end of the radius and one which followed an occupational tenosynovitis. Four of the patients were operated on, and three refused to submit to surgical intervention.

The majority of the reports, most of which have been from large surgical clinics, include but one or two cases. Furthermore, complete rupture of this tendon presents a clearcut clinical picture, which is not likely to be overlooked either by the patient or by the clinician. Witness, for example, the presentation by Salzer [4] before the Freie Vereinigung der Chirurgen Weins in December 1933 of a man, aged 22, with spontaneous rupture of the extensor pollicis longus tendon six weeks after a fissure fracture of the radius. A favorable result was obtained by transplantation of the tendon. Oppolzer, in discussion of Salzer's report, noted that in a series of more than eight hundred fractures of the radius, he observed only two late spontaneous ruptures of the extensor pollicis longus tendon. A third case followed tendo-

From the Daniel Baugh Institute of Anatomy of the Jefferson Medical College.

1. McMaster, P. E.: J. Bone & Joint Surg. **14**:93 (Jan.) 1932.
2. Horwitz, H.: Deutsche Ztschr. f. Chir. **234**:710, 1931.
3. Platt, H.: Brit. M. J. **1**:611 (April 11) 1931.
4. Salzer, A.: Zentralbl. f. Chir. **61**:587, 1934.

vaginitis crepitans. Good clinical results were obtained in the latter three cases by means of silk plastic sutures after the method of Länge.

A case of rupture of tendon of the long extensor muscle of the thumb is also reviewed by Lapeyre.[5] Operation was refused.

The reason for the rupture has been variously interpreted. Some attribute it to trauma, believing that the tendon becomes strangulated in the sheath by rupture of the tenaculum tendinum containing the nutrient blood vessels. Without nourishment the tendon degenerates, atrophies and then ruptures during some slight movement of the thumb. Others are of the opinion that it can occur only in the presence of pathologic changes in the tendon, such as tenosynovitis, tuberculosis, syphilis, previous inflammatory changes and tumors. Since no disease of the tendon can be considered as a predisposing cause in many cases, it seems reasonable to assume that some type of injury to the tendon occurred coincidentally with the fracture, culminating later in a complete rupture of the tendon.

However, one type of rupture is occasionally encountered, known as drummer's paralysis, which occurs largely as the result of some pathologic change in the tendon (occupational tenosynovitis). In some instances the rupture is complete, and in others, incomplete. The majority of the patients with this type of rupture are elderly. In thirty-nine of the fifty-one cases collected by Lapeyre the rupture was accompanied by fracture of the lower end of the radius. The fracture was often insignificant. The movement producing the rupture was often slight. The mechanism of this type of rupture of the tendon is probably best explained on the basis of attrition, analogous to a spontaneous rupture of the long tendon of the biceps muscle, which similarly occurs most commonly in elderly persons. Both of these tendons course through well developed osseous sulci, and this fixation subjects them to greater traumatism from the ordinary wear and tear. Drummer's paralysis occurs most commonly on the left side and among drummers who have been in service a long time.

Kleinschmidt stated that the experimentally produced fracture of the distal end of the radius is always associated with a coincidental transverse rupture of the sheath of this tendon, whereas the sheaths of the other tendons about the fractured radius remain intact. In many of the reported cases and in my cases, the fracture fragments were in excellent position, and no reduction of the fracture was necessary. This observation leads one to believe that factors other than the sharp end of a fracture fragment or manipulations incident to reduction are the cause of the rupture in many cases. No case of complete rupture was found reported in which the rupture occurred simultaneously with the inception of the fracture.

---

5. Lapeyre, J.: Presse méd. **40**:456, 1932.

A sound and tenable explanation of the mechanism of this injury to the tendon is best obtained by an analysis from the morphologic point of view. Three factors deserve consideration: (1) the anatomic variations in the groove of this tendon on the distal dorsal surface of the radius, (2) the anatomic course of the tendon and (3) the blood supply of the tendon. In order to ascertain the variations in the grooves on the dorsal surface of the distal end of the radius more than three hundred radii were studied. While there is a definite suggestion that certain types of formations exist, many minor variations are encountered that do not lend themselves readily to inclusion in groups. One fact stands out prominently, i. e., that the groove for the extensor pollicis longus tendon is the most prominent of the osseous sulci or incisurae on the dorsal surface of the distal segment of the radius (fig.).

The groove for the extensor pollicis longus tendon is narrow and oblique, and it is frequently bordered by well marked ridges. The incisurae for the other extensor tendons are somewhat broad and shallow. Considerable variation is present in the bony ridges bounding the sulcus of the extensor pollicis longus tendon (see fig.). The ridges and the groove give origin to strong fibers which strengthen the dorsal (posterior) radiocarpal ligament. The latter serves as an additional factor to fix this tendon in its narrow and oblique sulcus. Tracing the anatomic course of the tendon, it is to be recalled that on emerging from its osteofibrous groove beneath the posterior or dorsal radiocarpal ligament it passes obliquely across the dorsal surfaces of the carpus and over the tendons of the radial extensor muscles to gain insertion into the base of the second phalanx.

The unique anatomic course and the fixation of this tendon would appear to be important factors in the genesis of a rupture of the tendon and of the accompanying blood vessels. The importance of the anatomic fixation of blood vessels as one of the contributing factors in the causation of vascular injuries following a severe contusing violence has been commented on in a previous communication.[6]

That there is a scanty vascular supply of tendon tissue, particularly of segments that traverse osteofibrous channels, is well known. The repair of an injury to a tendon depends on the proliferation of tissue from several sources, most of the new tissue coming from the sheath and the surrounding connective tissue and the external peritoneum establishing vascular connections with the surrounding tissues. When an injury occurs in the part of a tendon occupying an osteofibrous sulcus repair takes place with great difficulty because of the absence of adequate surrounding tissues. The blood vessels supplying the tendon

6. Lipshutz, B.: Surg., Gynec. & Obst. **46**:62 (Jan.) 1928.

are for most part disposed longitudinally and traverse the areolar tissue which separates and surrounds the tendon bundles.

In the two cases here recorded the clinical picture of rupture of the tendon of the long extensor muscle of the thumb did not appear until five and six weeks, respectively, had elapsed after the occurrence of

Seven types of sulci for the tendon of the extensor pollicis longus muscle.

the fracture of the radius. Both of the fractures were in good position, and no manipulations were necessary for their reduction. Thus the only tenable explanation for the subsequent rupture of the tendon was an initial injury to the blood vessels of the tendon and the later development of necrosis of the tendon, owing to the failure of the surrounding vessels to establish a collateral circulation adequate for repair.

In a number of studies on the variations of the vascular tree, it is noteworthy that definite hypogenesis of the blood vessels is present in approximately from 5 to 8 per cent of all cadavers. Such hypogenesis consists of definite, smaller-calibered blood vessels and a decrease in the number of branches. The microscopic image confirms the latter findings, for the examination of a considerable number of arterial walls shows a wide variation in the general mural structure. The elastic content and the muscle content exhibit wide variations. In some instances the vessel wall, because of its tenuous mural structure, appears fragile; in other cases the vessels are strong and robust. These vascular variations are recorded independent of age and disease and represent distinct morphologic types. Conversely considered, the presence of additional branches and accessory arteries is not uncommon in the experience of any observant anatomist. That the structure of the arterial wall and the type of person are significant factors in the genesis of this injury appears to be supported by the following data: Twenty-two of thirty-two collected cases occurred in women. Of the two cases that I observed, one was in a woman, aged 22, who was somewhat undernourished, and the other, in a man of the type who usually shows arterial hypogenesis. The greater incidence of injury to this tendon in women may have its basis in a more frail structure of their vessel walls. In addition, the skeleton of women in general is characterized by the smaller development of processes and ridges for muscular attachment and weaker ligamentous structures, offering less protection to the contained tendon and its accompanying vessels.

## REPORT OF CASES

Case 1.—A girl aged 19 had a fracture of the lower end of the left radius, with very little displacement. Five weeks later, she felt something snap while wrapping a package and noticed that the distal joint of the thumb was hanging at an angle and could not be extended. She refused to submit to surgical intervention.

Case 2.—A man aged 26 had a fracture of the lower end of the right radius. A roentgenogram showed the fracture to be in excellent position. Six weeks after the fracture the patient noticed that the distal joint of the thumb was hanging at an angle of 140 degrees and could not be extended, indicating late rupture of the tendon of the extensor pollicis longus muscle. He did not hear or feel any tear and could assign no reason for the disability. At no time did he complain of pain. Four months after the fracture he was referred to me by his physician; he presented the typical picture of late rupture of the tendon of the pollicis longus muscle. At operation a longitudinal incision was made on the dorsal surface of the right wrist. The somewhat frayed glistening distal end of the ruptured tendon was located immediately distal to the caudal border of the dorsal radiocarpal ligament. As the course of the tendon was followed proximally, its sheath was found occupied by a frayed, grayish, thin, friable strand, extending to its muscular portion, indicating complete degeneration of the tendon from a point

immediately distal to the border of the dorsal radiocarpal ligament to its muscular portion. The destroyed part of the tendon was resected, since end-to-end approximation was impossible even with marked dorsiflexion. Because of the absence of any tendinous fibers in its proximal segment, the distal segment of the tendon was sutured to the extensor pollicis brevis muscle. The part was immobilized for three weeks. The result was good and the wound healed by first intention. There are now active movement of the distal phalanx to 110 degrees and active stretching in abduction and extension to 175 degrees. There is some thickening at the point of transplantation.

### TREATMENT

Repair by operation should be undertaken without delay. In cases of recent rupture the lesion can be repaired by direct suture, for degeneration of the tendon develops slowly. The studies of Mason and Shearon [7] showed that the tendon itself takes an important part in healing. Because of its scanty blood supply and the nature of tendon tissue, the repair progresses slowly. This tardiness of response in the tendon is compensated by an early response of the sheath. In suturing the ends of the tendon the point of attachment of the suture should be 1 cm. or more from the end of the stump so as to leave the latter untraumatized. It should be tied so that the knot does not lie between the ends of the tendon. Similarly the sheath should be disturbed as little as possible. It may be wise, as suggested by Mason and Shearon in their studies on repair of tendons, in performing end-to-end suture of a tendon in instances in which tension is considerable to put in a small segment of tendon graft. Many surgeons have advocated the use of fascia or other connective tissues for tendon grafts. The experimental studies of Mason and Shearon, however, indicated that a defect in a tendon should be filled with a tendon graft plus its sheath tissues and not with fascia, since the tendon forms true tendon which will not stretch as would ordinary connective tissue. Silk is the preferable material for sutures. In a number of the reported cases, silk plastic sutures inserted by the method of Länge gave very satisfactory results. If possible, the oblique course of the tendon should be preserved. But it is probably better not to use the original groove for the following reasons: 1. The inadequate surrounding tissue may interfere with repair. The connective tissues surrounding the tendon are of the greatest importance in the repair of a wound in a tendon. They convey blood vessels and lymphatic vessels to it and permit easy gliding of the tendon. 2. The presence of scarring and adhesions may make the groove unsuitable. The construction of a pulley by means of fascia lata, as recommended by Platt, may be used successfully to overcome the latter difficulty.

7. Mason, M. L., and Shearon, C. G.: The Process of Tendon Repair, Arch. Surg. **25**:615 (Oct.) 1932.

As an alternate method, when the entire proximal portion of the tendinous segment is destroyed the distal end of the tendon is attached to the extensor pollicis brevis muscle, as was done in case 2. This method prevents dropping of the thumb, but it cannot restore independent action of the long extensor muscle. The thumb is supported in extension for three weeks after any method of repair. Movement may be started cautiously from the sixth or seventh day, but no force should be exerted before the third week. Faradic stimulation of the muscle belly in the forearm can be used from the seventh day on.

# INTRACRANIAL PRESSURE IN HEAD INJURIES

ARTHUR A. ZIEROLD, M.D.
MINNEAPOLIS

Within recent years there has been a notable increase in what for lack of a better term have been classed simply as "head injuries." Although the term does not so specifically indicate, "head injury" has come to be synonymous with "brain injury." It has been assumed that cerebral trauma sufficient to cause subjective symptoms or to exhibit objective signs would be attended by the usual phenomena of injury elsewhere, viz., edema, hemorrhage and gross structural damage, and that occurring within a closed container such as the skull it would have as its most constant and formidable phenomenon increased intracranial pressure.[1] It is on this assumption that most of the accepted treatment of craniocerebral trauma is based. It is assumed that the most common occurrence following brain trauma is cerebral edema and that this is one of the prominent factors causing death from such injuries.[2] In accordance with this belief spinal drainage is resorted to as a routine procedure by many, and this is often supplemented by the use of hypertonic solutions administered intravenously or by mouth or bowel.[3] As a logical addition Fay [4] has advocated rigid restriction of fluid intake. All of these measures are directed toward the reduction of intracranial pressure. As a result of the stress laid on these measures the belief has become widespread that increased intracranial pressure is a common if not constant accompaniment to severe head injury. It has been my good fortune to have under observation for the past three or four years at the Minneapolis General Hospital between 300 and 400 cases of head injury each year. In attempting to analyze this material and to rationalize the treatment my associates and I have engaged in a rather exten-

---

From the University of Minnesota and the Minneapolis General Hospital.

1. (*a*) Peet, M.: Symptoms, Diagnosis and Treatment of Acute Cranial and Intracranial Injuries, New York State J. Med. **29**: 558, 1928. (*b*) McClure, R. D., and Crawford, A. S.: Management of Craniocerebral Injuries, Arch. Surg. **16**: 459 (Feb.) 1928. (*c*) Jackson, H.: Management of Acute Cranial Injuries, Surg., Gynec. & Obst. **34**: 494 (April) 1922. (*d*) Stewart, W. H., and Luckett, W. H.: Skull Fractures, Am. J. Roentgenol. **6**: 481, 1925.

2. (*a*) Dandy, W. E.: Acute Head Injuries, in Lewis, D.: Practice of Surgery, Hagerstown, Md., W. F. Prior Company, Inc., 1932, vol. 12, chap. 1, p. 265. (*b*) Sachs, E.: Diagnosis and Treatment of Head Injuries, J. A. M. A. **81**: 2159 (Dec. 29) 1923.

3. Sachs.[2b] McClure and Crawford.[1b]

4. Fay, T.: Head Injuries, J. Iowa M. Soc. **20**: 447, 1930.

sive study of all the factors involved. In reviewing the evidence presented by lumbar puncture it has been of interest to note how infrequent are the findings of abnormal intracranial pressure. This observation resulting from the routine examination of a number of records gave rise to the question of how frequently increased intracranial pressure is associated with cerebral trauma and what its relation to the cerebral symptoms is. The following discussion is an attempt to answer this query.

Much of the difficulty arising out of the study of cerebral trauma lies in the classification of the material studied. Some of it appears under the heading of concussion, some of it under the heading of skull fracture, some of it under that of the gross or the histopathologic observations at autopsy, and some under the broad general term of craniocerebral trauma. It is needless to say that such variation in classification is bound to result in considerable variation in findings. A comprehensive and entirely satisfactory classification would be, perhaps, too involved and unwieldy by reason of the many necessary qualifications, and an attempt has been made here to compromise the difficulties by grouping the material under one symptom which is common to all cases and is easily measured. Inasmuch as the most constant and most specific evidence of brain dysfunction is the loss of consciousness it has been taken as the criterion for the basis of classification in this series. To avoid the inclusion of trivial injuries and injuries with only slight evidence of cerebral damage the minimal limit of unconsciousness has been arbitrarily placed at one hour.

## MATERIAL AND METHOD OF STUDY

The series comprises 128 cases of head injury with periods of unconsciousness extending from one hour to several days. These cases have been carefully studied with regard to the following data: age, sex, period of unconsciousness, subjective complaints, neurologic findings, clinical behavior, results of roentgen and laboratory examinations and spinal fluid pressures. In each of the cases a careful record was kept of the state of consciousness. Care was taken to differentiate between stupor, aphasia and the irrational conscious state. The period of complete unconsciousness was noted, and during this time the blood pressure was recorded at thirty minute intervals, likewise the pulse rate, temperature and respiratory rate. Following the return of consciousness these observations were recorded hourly until the patient became symptom-free. In each instance as careful a physical examination was made as the patient's condition would permit directly on his admission to the hospital and was repeated at daily intervals. Examination of the neuromuscular mechanism was made, and the skin and tendon reflexes were recorded; also, careful examination was made of the eye with regard to the pupillary reflexes and the extra-ocular movements. Ophthalmoscopic examination was made at about the fourth or sixth day following injury. As the series contained no case suggestive of brain tumor, and as no evidence of spinal fluid block could be demonstrated, a direct estimate of intracranial pressure was made in terms of spinal fluid pressure obtained by puncture in the second or third lumbar interspace. With the patient in the horizontal position and lying

on his side, lumbar puncture was performed on the second day and as frequently thereafter as conditions warranted. In performing lumbar puncture the needle was connected directly to a water monometer of 1 mm. caliber, and no fluid was allowed to escape before taking the reading. In order that the figures thus obtained might be compared with readings made in millimeters of mercury it was necessary to correct for capillarity of the instrument. On repeated observation this was fixed at 15 mm. After the pressure reading had been obtained, a few centimeters of fluid was examined for the presence of blood. Only those cases in which gross blood could be identified in the cerebrospinal fluid were classed as positive for blood. In no instance in this series was any attempt made to affect the intracranial pressure by spinal drainage, the use of hypotonic solutions or restriction of fluid intake. In addition to the foregoing record, postmortem examination of the brain was made in each of the fatal cases and the observations appended.

## ANALYSIS OF DATA

From the assembled individual records the data were collected and catalogued as follows: When the cases were grouped according to patients' ages the greatest number fell within the 20 to 25 year period; the frequency fell off gradually as old age approached, but there were secondary peaks at 35 and 45 years. This curve of distribution (chart 1) probably signifies that the greatest exposure to head injuries occurs in early adult life and that exposure to such injuries gradually decreases as the person's activities decrease. It is also probable that the secondary peaks of the curve indicate the time of life when the person's activities are still unrestricted but when his neuromuscular mechanism is showing the first signs of age, of which he is unaware and by reason of which he is less able to avoid injury than in early adult life. As he grows older his exposure to injury is limited, he also exhibits a greater degree of caution, and the curve falls away rather sharply.

In the 128 cases there were 20 deaths, representing a mortality of 15.6 per cent, distributed over the age periods designated in chart 2. The greatest number of deaths fell within the 55 to 60 year period. As persons in this period were not subject to injuries of greater severity than those occurring in youth it may be supposed that the older person is less able to survive an injury to the brain than the young one.

The distribution of intracranial pressures over the whole series is represented in chart 3. It will be noted that by far the greatest number of cases are grouped under the 125 mm. level. From this point the curve drops abruptly to the 200 mm. level, and from here, with the exception of a moderate rise at the 225 mm. level, it flattens out to continue in an almost straight line to the 500 mm. mark. The final pressure reading of the curve indicates not 500 mm. alone but 500 mm. or over. In considering these figures and those which follow some thought must be given the term "normal." As Ayer [5] stated, "The normal spinal

5. Ayer, J. B.: Cerebrospinal Fluid Pressure, in Dana, C. L., et al.: Cerebrospinal Fluid, New York, Paul B. Hoeber, Inc., 1926, p. 160.

fluid pressure may be anything," and this statement seems true in view of the wide limits of variation recorded by various observers. Barré and Schrapf [6] on the basis of 310 observations concluded that the normal limits of variation of spinal fluid pressure lie between 50 and 200 mm. of water. Ayer placed the figures at 100 to 200 mm., stating that any reading above 250 and 300 mm. is distinctly abnormal. Weigeldt [7]

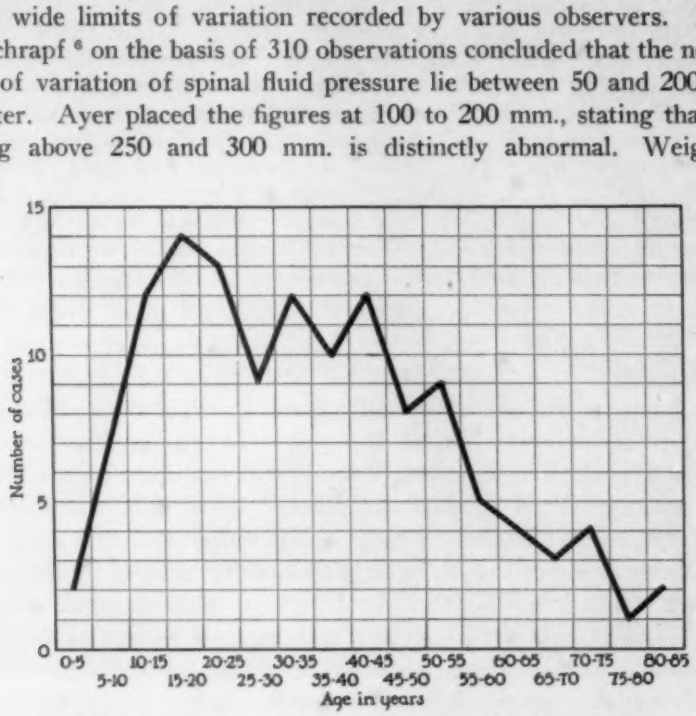


Chart 1.—Incidence of head injuries according to age.

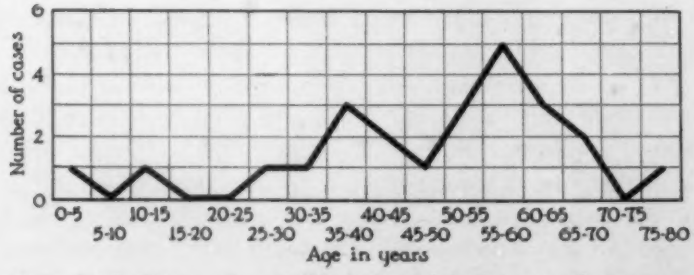


Chart 2.—Incidence of mortality in head injuries according to age.

determined a much narrower range of variation, placing the figures at 150 to 170 mm. He also stated that a pressure over 300 mm. is distinctly abnormal. Dreyfuss and Becker [8] established the upper limit of

6. Barré, J.-A., and Schrapf, R.: Sur la pression du liquide céphalo-rachidien, Bull. méd., Paris **35**: 63, 1921.

7. Weigeldt, R. W.: Studien zur Physiologie und Pathologie des Liquor Cerebro-Spinalis, Jena, Gustav Fischer, 1923, p. 150.

8. Dreyfuss and Becker, quoted by Ayer.[5]

normal at 200 to 220 mm.; Key and Retzius,[9] at 160 to 200 mm., and Cottin and Saloz,[10] at 200 to 300 mm. These are but a few of the conclusions of many workers, but they probably represent a reasonably accurate estimate. For the purposes of this study it was necessary to establish an upper limit of normal spinal fluid pressure and this has been placed at 180 mm. as this figure appears to be well within the upper limits of normal as determined by the majority of observers. As previously stated, cerebrospinal fluid pressure has been taken as a measure of the intracranial pressure, and to avoid confusion the latter term will be used in the comment which follows. Of the 128 cases studied 21, or 16.4 per cent, exhibited intracranial pressures above 180 mm. In

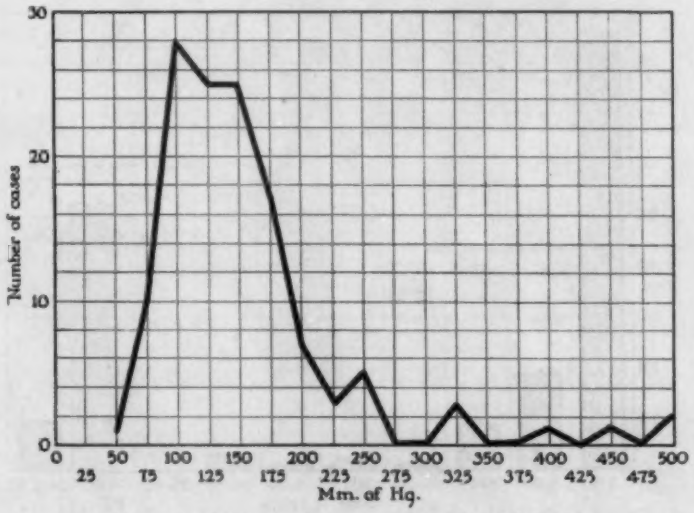


Chart 3.—Intracranial pressure in head injuries.

only 7 of these, or 5.4 per cent, was the pressure in excess of 300 mm., as may be noted in the curve of distribution in chart 3. While the latter figures denote distinctly abnormal pressures, it is worthy of note that 5 per cent is a remarkably small part of the total.

Of the total number of patients 41 sustained fractures of the skull as demonstrated by roentgen examination and 87 were classed as having no skull fractures. No apparent relationship could be established between skull fracture and severity of brain injury. As evidence of the severity of brain damage or injury, the cases were again classified according to periods of unconsciousness. This is shown in chart 4. The greatest

9. Key, E. A. H., and Retzius, G.: Studien in der Anatomie des Nervensystems und des Bindegewebes, Stockholm, Samson & Wallin, 1875-1876.

10. Cottin and Saloz: La mesure de la pression du liquide céphalo-rachidien, Rev. de méd., Paris **35**: 511, 1916.

number of cases is seen to fall within the one to five hour period. From this point to the ten hour period the number of cases decreases rapidly to reach a minimum at the twenty-five hour period only to rise again at the forty-five hour period. As previously mentioned, this curve of distribution cannot be correlated with that of skull fracture. The spinal fluid removed after reading the pressure was found to be bloody in 73 cases, or 57 per cent. Vomiting was observed in 60 cases, or 46.9 per cent. Examination of the clinical record relative to pulse rate and blood pressure revealed only slight and insignificant variations. In only 1 case did the rise in blood pressure and the fall in pulse rate occur as described by Cushing.[11] It was noted that in the terminal state the

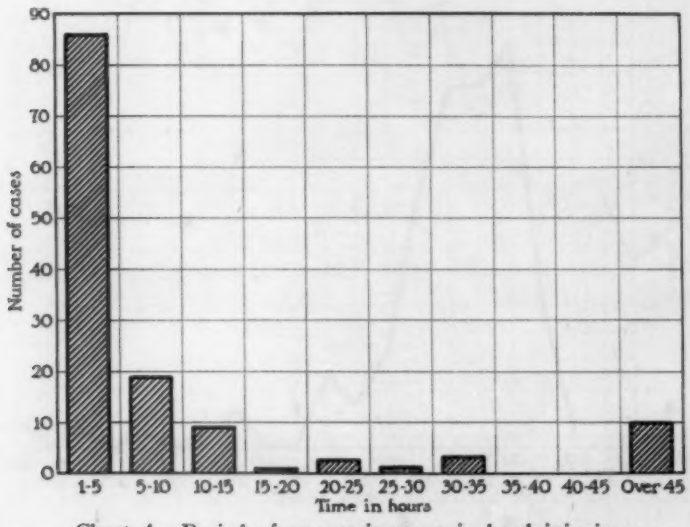


Chart 4.—Period of unconsciousness in head injuries.

pulse became rapid and the blood pressure fell, but this circumstance was not uniformly related to intracranial pressure.

Again, classifying the cases on the basis of intracranial pressures of 180 mm. or more, the clinical data were reassembled and correlated with the two groups of normal and abnormal pressure to determine whether or not the presence or absence of abnormal intracranial pressure could be determined and its intensity measured by the various clinical phenomena observed. It was found by comparing the two curves as in chart 5 that the age incidence and the incidence of abnormal intracranial pressure were in no way related. That is to say, the response of the young person is proportionately the same as that of the older person in terms of intracranial pressure. Likewise it was found that

11. Cushing, H.: Blood Pressure During Cerebral Compression, Bull. Johns Hopkins Hosp. **12**: 290, 1901.

no causal relationship obtained between the periods of unconsciousness and the accompanying intracranial pressures, as may be determined by examining chart 6. It will be noted that the percentage of patients having abnormal intracranial pressure is quite as high in the group having a period of unconsciousness of one hour as in those having a period of unconsciousness of forty-five hours or more. The relation of intracranial pressure to skull fracture is equally inconclusive. Of the 41 patients exhibiting fractures of the skull 9, or 21.9 per cent,

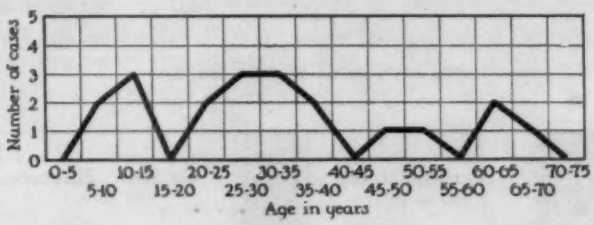


Chart 5.—Incidence of abnormal intracranial pressure according to age.

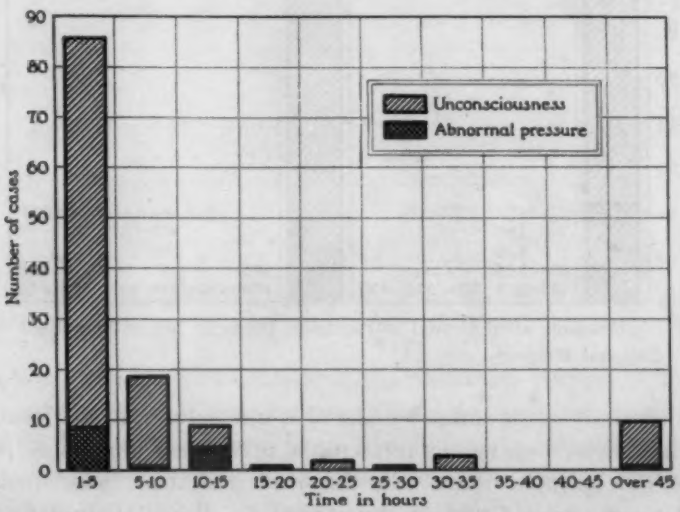


Chart 6.—Relation of period of unconsciousness to period of abnormal intracranial pressure.

exhibited intracranial pressure of more than 180 mm. and of the remaining 87 patients in whom no skull fracture could be proved 10, or 11.5 per cent, exhibited abnormal intracranial pressure. It appears from this that abnormal intracranial pressure is definitely more frequent in patients having fracture of the skull, but examination of the curve of distribution of the individual cases as seen in chart 7 leads to the belief that some other more important factor is the determining cause. This is further substantiated by the observation that of the 41 patients with skull fractures 34, or 82.9 per cent, exhibited gross blood in the spinal fluid and

of the 87 in which no skull fracture was shown only 22, or 25.2 per cent, exhibited bloody spinal fluid. Of the total number of patients studied 56, or 43.7 per cent, exhibited gross blood in the spinal fluid. This in itself is of little importance until it is correlated with abnormal intracranial pressure; in all patients having abnormal intracranial pressure a bloody spinal fluid was found. This finding appears to indicate a direct relationship between hemorrhage and intracranial pressure. In close agreement with this observation are the observations at autopsy. Of the 20 patients who died 7, or 35 per cent, had an intracranial pressure of more than 180 mm. and, of these, 6 had extensive subdural hemorrhage while 1 presented extradural hemorrhage.

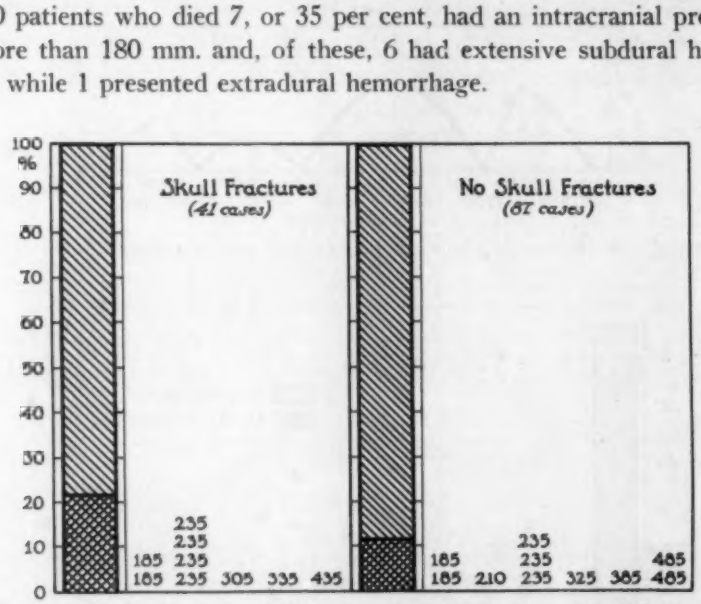


Chart 7.—Relation of abnormal intracranial pressure (cross-hatching) to skull fracture (diagonal stripes).

Further study of the autopsy material is interesting. It will be noted in table 1 that the patients having intracranial pressure of more than 180 mm. fall into two groups: those who survived and those who died. Of the first there were 14 and of the second 7. It will be noted that in those surviving the intracranial pressures show substantially the same distribution as in those who died and that the extremes of intracranial pressure appear in both groups. Also in examining table 2, in which the 20 patients who died are grouped again into two groups, one having pressures over 180 mm. and the other pressures under 180 mm., it will be seen that the majority of these patients died with relatively low intracranial pressures. From the evidence of these two tables it may surely be said that in view of the fact that two thirds of the patients died with normal intracranial pressure and that of the group having abnormal intracranial pressure, those surviving had pressures comparable to those who died there is no definite or causal relationship between intracranial

pressure and death. That is to say, that by no means is a fatal outcome to be expected in cases of head injury with abnormal intracranial pressure, and as a corollary it might be stated that the determining factor in death is not the degree of intracranial pressure which may exist but whether or not it affects a vital center.

Thus far mention has been made only of hemorrhage as bearing any relation to abnormal intracranial pressure. The evidence in all cases examined post mortem tends to support this relationship inasmuch as in no instance was any evidence of cerebral edema found. In no instance was the dura tense except as a result of hemorrhage, and in no instance was there any demonstrable amount of subarachnoid fluid. The cause of death in head injury is by no means clear, and although it is

TABLE 1.—*Abnormal Intracranial Pressures of Patients Who Survived and of Patients Who Died*

| Survived (14 Patients) | | | | | | | | | Died (7 Patients) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 185 | | | | 235 | | | | | | 235 | | | |
| 185 | | | 225 | 235 | | | | | | 235 | | | |
| 185 | 200 | 210 | 225 | 235 | 305 | 310 | 385 | 500 | 190 | 235 | 325 | 430 | 500 |

TABLE 2.—*Distribution of Intracranial Pressures Over and Under 180 Mm. in Patients Who Died*

| Pressures Over 180 Mm. (7 Patients) | | | | | Pressures Under 180 Mm. (13 Patients) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 235 | | | | | | 100 | | | | 155 | |
| | 235 | | | | | | 100 | | | 135 | 155 | |
| 190 | 235 | 325 | 430 | 500 | 75 | 80 | 100 | 105 | 110 | 135 | 155 | 165 |

in effect the result of disturbance in the medullary portion of the brain, and Dandy suggests it may be due to localized pressure, it certainly is not, in the light of the figures given in a foregoing paragraph, the result of generalized abnormal intracranial pressure in the majority of instances. As regards the clinical data, correlation with abnormal intracranial pressure is difficult and inconclusive except for the negative findings. Examination of the eyes as to pupillary change and extra-ocular muscular dysfunction reveals little of value. Of the patients having abnormal intracranial pressure only 6, or 31.5 per cent, showed eye changes. As these changes occurred in 13.7 per cent of the patients with normal intracranial pressure they could not be taken as indicative of the presence or of the degree of abnormal pressure. As might be expected, papillary edema was rather rare. It was of course absent in all cases in which the intracranial pressure was normal and present in only 4 of the 21 cases in which the pressure was abnormal. This low figure is probably due more to the lack of time for development than to the

degree of abnormal pressure. The findings with regard to the cardiovascular phenomena were of interest particularly in the light of a generally accepted view of their importance. In only 1 case was the onset of intracranial pressure signalized by a fall of pulse rate and a rise of blood pressure. Even in the fatal cases, although death was immediately preceded by a rise in pulse rate and a fall in blood pressure, the same circumstance was noted in fatal cases without increase in intracranial pressure. Observations with regard to vomiting were interesting because this, too, has been commonly identified with increase of intracranial pressure.[2a] In view of the experience of many observers regarding intracranial pressure in cases of brain tumor there can be no question but that vomiting is an almost constant symptom of high intracranial pressure exerted over some period of time. This, however, does not appear to be true in cases of acute head injury. Of all the patients in the series 60 vomited. Of the 21 patients with pressure of 180 mm. or more, 9, or 42.8 per cent, vomited, and of the 107 remaining patients 51, or 47.6 per cent, vomited. From these figures it appears that the occurrence of vomiting is in itself neither an evidence of increased intracranial pressure nor a measure of its degree.

## CONCLUSIONS

Assuming that the foregoing data are accurate and sufficiently extensive to be of statistical value, it appears that the following conclusions are reasonable: 1. In cases of severe head injury abnormal intracranial pressure is not a frequent occurrence, and only in a small percentage of the cases will it exceed 300 mm. 2. Abnormal intracranial pressure is not a frequent finding in the fatal cases nor is it a frequent cause of death. 3. Unconsciousness is not in itself evidence of abnormal intracranial pressure nor is the period of unconsciousness a measure of the degree of intracranial pressure. 4. Unless abnormal intracranial pressure develops rapidly and is of sufficient degree to approximate the blood pressure, changes in pulse rate and blood pressure do not develop, and such changes cannot be considered as satisfactory evidence of abnormal intracranial pressure. 5. Neurologic findings, such as ocular reflex change and reflex changes elsewhere, are not signs of increasing intracranial pressure. 6. Increased intracranial pressure is almost invariably attended by blood in the spinal fluid. 7. When abnormal intracranial pressure occurs it is the result of hemorrhage, extradural, subdural or within the substance of the brain. 8. It is not probable that abnormal intracranial pressure of a degree sufficient to endanger life is susceptible to treatment by spinal drainage or by the use of hypertonic solutions. It also appears reasonable that such few abnormal intracranial pressures as occur which are of sufficient degree to endanger life are best treated surgically.

# FIFTY-EIGHTH REPORT OF PROGRESS IN ORTHOPEDIC SURGERY

JOHN G. KUHNS, M.D.
EDWIN F. CAVE, M.D.
SUMNER M. ROBERTS, M.D.
JOSEPH S. BARR, M.D.
AND
ROBERT J. JOPLIN, M.D.
BOSTON
JOSEPH A. FREIBERG, M.D.
CINCINNATI
JOSEPH E. MILGRAM, M.D.
NEW YORK
AND
ROBERT I. STIRLING, F.R.C.S. (EDIN.)
EDINBURGH, SCOTLAND

## CONGENITAL ABNORMALITIES

*Congenital Coxa Vara.*—In a general discussion of congenital coxa vara, Roederer [1] states that two conditions quite different in their etiology and their course can be differentiated. The early rachitic coxa vara has a very deformed head and marked osteoporosis with a wide oblique epiphyseal line, while congenital coxa vara shows an intact femoral head with normal osseous density and a normal epiphyseal line almost vertical in direction. In congenital coxa vara deformities of the head come slowly with use. Often the lesion is unilateral. The deformity is one of faulty development of the femoral neck; there may be shortness of the femoral neck, or the upper portion only may develop into a hooked process, or the neck may not develop at all. Many persons with coxa vara are able to lead a fairly normal existence, but later arthritis develops with increased density of the head. Treatment with repeated application of plaster casts even in small children has been unsuccessful, and surgical intervention, usually osteotomy, has been necessary. In adults abduction and extension in a plaster cast with a subtrochanteric osteotomy are most helpful.

*Physiologic Treatment of Congenital Dislocation of the Hip.*—Stewart [2] formulates the principles of treatment on the basis of embryo-

---

This report of progress is compiled from a review of 207 articles selected from 297 titles appearing in medical literature approximately between Feb. 22, 1935, and July 1, 1935. Only those which show progress were chosen for review.

1. Roederer, C.: Bull. Soc. belge d'orthop. **7**:109, 1935.
2. Stewart, S. F.: J. Bone & Joint Surg. **17**:11, 1935.

logic and phylogenetic study and strives to show the possibility of obtaining the necessary preoperative information by examination of x-ray films. Three great lessons are to be learned: (*a*) The degree of antetorsion and the extent of ischial defect are reciprocal factors. (*b*) It is not the defective iliac portion of the acetabulum which causes dislocation when the hip is adducted after conjugation, but rather the folding up of the inferior capsule, which acts as a lever to lift the hip out of the socket. (*c*) In most, if not all, hips treated by closed reduction, the femoral head erodes its way through the infolded capsule before it becomes completely conjugated; otherwise it would be dislocated as it is brought into adduction. The original article should be read in order to comprehend the author's meaning, but the final sentences may be given here without comment: "We 'resign to the secular Arm' the pumphandling manipulators and users of racks. We would, however, emphasize the value of marginal additions to the acetabular bearings and we have pointed out the way for their proper localization. In the hips which have retained the reptilian form it would seem that a refined bifurcation operation would be desirable."

*Comparative Analysis of the Results of Open and Closed Reductions in Congenital Dislocation of the Hip.*—Kidner [3] gives a candid comparison of the results in 26 cases in which 34 luxations were reduced by open operation and 13 cases in which 22 luxations were reduced by the closed method. The original paper deserves reading, and only the final conclusions are given here: 1. The results of closed reduction, even in young children, are often unsatisfactory, although the only perfect end-result from the clinical and roentgenographic standpoints falls in this group. 2. Force should never be used to obtain reduction. 3. Except in rare cases, the anatomic changes inherent in congenital dislocation require open surgical treatment if reduction is to be intelligently performed and permanently satisfactory. 4. The results of open reduction are better than those of closed. 5. Open reduction is not dangerous. 6. A small incision which does little damage to soft parts or muscle attachments is sufficient. 7. Adhesion of the capsule to the side of the ilium is the major factor in preventing reduction. 8. The period of immobilization in plaster is much shorter after open than after closed reduction.

*Open Reduction in Congenital Dislocation of the Hip.*—Farrell and Howorth [4] summarize the results in a series of 492 cases in which treatment was by the closed method, in 42 per cent of which the method was successful. In a series of 122 cases, successful open reductions were obtained in 77 per cent. "Good functional results were secured

3. Kidner, F. C.: J. Bone & Joint Surg. **17**:25, 1935.
4. Farrell, B. P., and Howorth, M. B.: J. Bone & Joint Surg. **17**:35, 1935.

in 78 per cent of the open reductions." They conclude that closed manipulation is the method of choice during the first year of life and may be attempted up to 3 years of age. The shelf stabilization is the most satisfactory operation for most children over 6 years of age. Traction with adhesive plaster is of little or no value before reduction; after reduction it may be useful when there is tension at the hip. The chief factors in redislocation are the size and shape of the acetabulum and the redundancy of the capsule. When the capsule is adherent it should be freed superiorly, a sufficient section removed, and an anatomic closure secured. Anteversion favors redislocation and should be corrected when such is the case. The principal causes of postoperative limitation of motion which can be avoided are tension of the tissues about the hip joint, damage at the superior acetabular margin and the presence of a large area of raw bone or raw soft tissue. Coxa plana is due to a circulatory disturbance caused by tension on the capsule and adjacent tissues and is almost wholly avoidable.

*Painful Congenital Subluxation of the Hip.*—Five women ranging in age from 29 to 46 years were operated on by Owre [5] for the relief of pain from congenital dislocation of the hip. The method of Lance was used. A plate of bone from 2 to 3 mm. thick and from 2 to 3 cm. wide was turned down from the ilium over the femoral head and fastened to the articular capsule with catgut. A long tibial graft was broken and laid over this bone plate like roof-tiling, with the periosteum downward. If abduction at the hip was less than 45 degrees a subtrochanteric osteotomy was also performed. A plaster cast with the hip in extreme abduction was worn until healing had taken place. The author mentions that after operation these patients were free from pain on walking.

*Coxa Magna.*—Ferguson and Howorth [6] report a group of cases under the term "coxa magna"—a condition in which there is enlargement of the femoral head and neck due to local disturbances of circulation. In 13 cases the symptoms and signs of coxa plana were presented without the abnormalities of bone or cartilage characteristic of coxa plana or slipping of the upper femoral epiphysis. The cause in each case was apparently a disturbance of circulation in the femoral head produced by sclerotic changes in the soft tissues about the femoral neck following subacute arthritis probably infectious in origin. For such a condition they advise treatment by rest in bed without immobilization and the removal of foci of infection. They believe coxa magna

5. Owre, A.: Acta chir. Scandinav. **76**:369, 1935.

6. Ferguson, A. B., and Howorth, M. B.: Coxa Magna: A Condition of the Hip Related to Coxa Plana, J. A. M. A. **104**:808 (March 9) 1935.

to be due to the same pathologic conditions producing coxa plana, but less severe. The article is illustrated by roentgenograms and photomicrographs of specimens.

### DISTURBANCES IN MINERAL METABOLISM

*Mineral Metabolism in Osteogenesis Imperfecta.*—Swanson and Iob [7] report studies of the mineral metabolism in a case of osteogenesis imperfecta. Viosterol, 30 drops daily, was given with apparent improvement in the retention of calcium and phosphorus. Poor retention of sodium was the most striking observation. An analysis of bone showed a low total ash content but did not confirm the high values reported for magnesium, sodium and potassium. A review of the findings in other cases reported in medical literature is given.

*Calcium and Phosphorus Metabolism in Osteomalacia.*—The response of 4 patients suffering from osteomalacia was studied by Liu and his collaborators.[8] Briefly, the authors found that although the abnormal conservation of calcium because of lack of vitamin D is identical in all cases of osteomalacia, two types are recognizable by the serum calcium and serum phosphorus levels; in one the calcium is low and the inorganic phosphorus is normal; in the other, this is reversed. In the former tetany and lenticular opacities are present; in the latter bone tenderness and skeletal deformities are more common. Decalcification may be mild in the former and advanced in the latter. Both types respond to vitamin D therapy. Serum inorganic phosphorus when low rises rather slowly, being susceptible to the influence of factors other than vitamin D. It is not known whether or not the state of the parathyroid glands exerts some controlling influence.

*Conception of Osteomalacia and Its Importance to China.*—Maxwell [9] states that the name "osteomalacia" should be replaced by the term "adult rickets," for it is a sign which may appear in a number of disorders. This disease, caused partly by actual shortage of calcium and phosphorus combined with a lack of vitamin D, has as its main symptoms pain in the back and thighs and softening of the bones of the pelvis, chest, long bones and vertebrae. It has to be distinguished from osteomalacia due to: (1) hyperparathyroidism, (2) hyperthyroidism, (3) steatorrhea, (4) renal rickets, (5) diabetes and (6) malignant disease. The author estimates that at least 100,000 cases are scattered over North China. Though it can occur in men, it is far more common

7. Swanson, W. W., and Iob, L. V.: Calcium and Phosphorus Content of Offspring After Feeding Vitamin D to Mother Rat, Am. J. Dis. Child. **49**:43, (Jan.) 1935.

8. Liu, S. H.; Hannon, R. R.; Chu, H. I.; Chen, K. C.; Chou, S. K., and Wang, S. H.: Chinese M. J. **49**:1, 1935.

9. Maxwell, J. P.: Chinese M. J. **49**:47, 1935.

in women; pregnancy, which adds an extra drain on the calcium store, is largely the cause. Means of prevention may be divided into three parts: (1) general—sunshine and exercise; (2) dietary—health-giving, adequate diet; (3) medicinal—any one of the vitamin D preparations on the market.

### CHRONIC ARTHRITIS

*Hyperpyrexia in Arthritis.*—Hench and his associates [10] report their results with the use of fever therapy in infectious and in gonorrheal arthritis. They found that infectious (atrophic) arthritis responds poorly to fever therapy. Of 60 patients so treated, none were completely relieved, 18 per cent were markedly relieved, 12 per cent moderately relieved, 20 per cent slightly benefited, and 50 per cent received no benefit. On the other hand, of 16 patients with gonorrheal arthritis, 90 per cent were either cured or markedly relieved. The authors feel that fever therapy provides direct sterilization of the affected joints, not only in the acute but also in the chronic stages of the disease.

Short and Bauer [11] of the Massachusetts General Hospital also treated a group of patients suffering from rheumatoid arthritis by diathermy, producing hyperpyrexia, with essentially similar results. Of 25 patients receiving 71 treatments, 20 per cent showed no improvement at any time, and 80 per cent showed temporary improvement, which was maintained in 20 per cent until the end of the follow-up period. The authors conclude that although the treatment injured none of the patients, it was such an ordeal that only in an occasional case is the use of diathermy justified in the treatment of rheumatoid arthritis.

Atsatt and Patterson [12] found that 7 of 8 patients with gonorrheal arthritis were completely relieved by artificial fever therapy.

EDITORIAL NOTE.—From these and other reports in the literature it seems that hyperpyrexia is not indicated in the usual cases of atrophic arthritis, but that in cases of gonorrheal arthritis it offers one of the most effective methods of treatment.

### POLIOMYELITIS

*Active Immunization Against Poliomyelitis.*—Brodie,[13] after discussing the ineffectiveness of isolation and other measures for the con-

10. Hench, P. S.; Slocumb, C. H., and Popp, W. C.: Fever Therapy: Results for Gonorrheal Arthritis, Chronic Infectious (Atrophic) Arthritis and Other Forms of "Rheumatism," J. A. M. A. **104**:1779 (May 18) 1935.

11. Short, C. L., and Bauer, W.: Treatment of Rheumatoid Arthritis with Fever Induced by Diathermy: Follow-Up Study, J. A. M. A. **104**:2165 (June 15) 1935.

12. Atsatt, R. F., and Patterson, L. E.: California & West. Med. **42**:94, 1935.

13. Brodie, M.: Am. J. Pub. Health **25**:54, 1935.

trol of poliomyelitis, ventures the prophecy that effective and practical vaccination against this disease will soon be possible. He describes experiments on monkeys and on 12 children in which various inactivated virus suspensions were used. A virus suspension inactivated with solution of formaldehyde was most effective in producing antibodies in monkeys. The usual vaccine dosage was 5 cc. of the virus suspension in one or two doses. The duration of the immunity is not known, but in the monkeys used in the experiments it has lasted for two years.

*The Problem of Immunization Against Poliomyelitis.*—Schultz and Gebhardt [14] report from the bacteriologic laboratory of Stanford University their attempts at passive and active immunization of monkeys against poliomyelitis. Of 91 monkeys which received immune serums (about 5 cc. per kilogram) only 28 or 30 per cent escaped infection. Seven per cent of the 27 control animals also escaped infection. A relationship was noted between infection and the dose of virus given. For protection against a given dose of virus a disproportionately high concentration of antibodies was necessary. It was noted that the administration of immune serums tended to prolong the period of incubation but did not seem to lessen the degree of paralysis once infection was established. An attempt was made to immunize actively 15 monkeys with virus suspensions inactivated with 0.1 per cent formaldehyde. Twenty-four days after the final injection for immunization the animals were inoculated intracerebrally with the poliomyelitic virus, and all acquired poliomyelitis. In another series (number not given) the Kolmer technic was used to immunize the monkeys. All of these animals subsequently were inoculated, and in all of them poliomyelitis developed. The authors feel that artificial immunization is difficult since it seems to be developed on active neural infection. The immunity which develops on the administration of vaccines is humoral rather than cellular, and its durability as well as its degree is questionable.

## THE BACK

*Mechanics of Physical Signs in Injuries of the Lower Parts of the Trunk.*—Brahdy [15] discusses the various mechanical difficulties occurring in injuries to the lower part of the trunk, i. e., sacro-iliac and lumbosacral strain, lesions of the hip joint, coccygodynia, gluteal bursitis, muscle spasm, etc. He gives a good review of the physiology of the normal motions of the trunk and explains the mechanics of the various injuries mentioned. He furnishes a good review of the entire subject.

---

14. Schultz, E. W., and Gebhardt, L. P.: California & West. Med. **43**:111, 1935.
15. Brahdy, L.: Surg., Gynec. & Obst. **60**:802, 1935.

NEOPLASMS

*Endothelial Myeloma, or Ewing's Sarcoma.*—As a part of a symposium on the treatment of primary tumors of the bone, Coley [16] reports results from the treatment of Ewing's sarcoma by means of a mixture of cultures of Streptococcus erysipelatis and Bacillus prodigiosus, either alone or in combination with radiation. His conclusions are: 1. Irradiation as the primary method of treating operable endothelioma of the long bones should be abandoned except in the presence of a condition that renders amputation inadvisable. 2. While the brillant results of conservative treatment (with toxins and radiation) in a number of cases of inoperable endothelial myeloma, some with extensive metastases, seem to justify an attempt to save the limb in early operable cases, the actual results of conservative treatment in such cases have been so poor that its continuation is not justified. 3. The results of surgical intervention alone cannot be determined from his own series, as he has not used the method in a single case. The Johns Hopkins Hospital group treated in this way shows 10.6 per cent well for five years. 4. While the group treated with toxins alone shows the highest percentage of five year cures, the majority of these patients were treated by other men under his direction and he has no way of knowing the number of failures not reported; hence he cannot give the exact percentage of five year cures with toxins alone. 5. The results obtained by early amputation followed by prolonged treatment with the aforementioned toxins seem to suggest this as the method of choice.

*Place of Biopsy in Bone Sarcoma.*—Every sentence of Ewing's [17] short article is of such significance that the article does not lend itself to abstracting. Only the motivating sentences of this very instructive paper can be given here. The paper itself is recommended for study. He states: 1. The biopsy should be the last step in the diagnosis of bone sarcoma. The clinical history and the roentgen observations, in experienced hands, yield a positive or a practically certain diagnosis in the majority of cases. 2. The whole clinical and roentgen picture usually furnishes a better conception of the diagnostic and therapeutic problem than can be obtained from a biopsy. 3. Few surgeons realize the limitations of the histologic diagnosis of bone tumors and the conditions which simulate or accompany them. (These are described in detail.) 4. Numerous unexpected complications arise from biopsies on bone tumors, and while the individual surgeon may claim that he has not encountered them very often, the total damage done forms a serious objection to the biopsy. 5. Bone sarcomas are allowed to run along,

16. Coley, W. B.: Am. J. Surg. **27**:7, 1935.
17. Ewing, J.: Am. J. Surg. **27**:26, 1935.

in the hands of all types of practitioners, until the disease becomes so obvious that no further delay can be tolerated and resort is finally made to the roentgenogram and then to biopsy. So long as this attitude prevails there will be few cures. 6. An aspiration biopsy by bore needle has been remarkably successful in revealing the structure of bone tumors. When this method becomes a familiar routine there will remain a very restricted field for the old surgical biopsy.

*Myeloma.*—According to Mathias,[18] the myeloma lies in the boundary region between bone tumors and hemoblastoses. It apparently arises from all the immature elements of the bone marrow. Its clinical varieties are many. The author reports the occurrence of a tumor of the skull in a 65 year old man. Radiation was used twice. Thereafter surgical excision was performed. A completely circumscribed tumor involving the dura mater was removed together with the overlying scalp. Histologic examination revealed a myeloma with the cell structure of a plasmocytoma. Elsewhere no evidence of neoplastic formation could be found. Eighteen months after operation the patient was still entirely well and clinically free from metastases. The author remarks that there may be, as in this case, isolated surgically accessible myelomas.

*Cancer Metastases in Bone.*—Fort [19] reviews the histories of 308 cases of cancer in which metastases were observed in bone. He found that carcinoma of the breast and of the prostate were responsible for from 50 to 70 per cent of the cancer metastatic in bone. Hypernephroma and carcinoma of the colon, thyroid, lungs and uterus metastasized frequently; metastases from cancer in other localities were rare. Metastases from cancer of the skin were very rare (2 cases of melanoma in the author's series). The most frequent sites of metastases were the pelvis, spine, ribs, femur and skull in the order named. Osteoclastic metastatic lesions were four times as frequent as osteoplastic.

### ROENTGEN TECHNIC

*Roentgen Evidence of Injuries to the Attachment of the Supraspinatus Tendon.*—Henry [20] cites 6 cases to demonstrate that by an anterior-posterior view of the shoulder, with use of soft tissue roentgen technic and with the arm in adduction and extreme external rotation, the point of insertion of the supraspinatus tendon will be shown in silhouette on the humerus. His findings agree with those of Codman and others: 1. Immediately after injury fine spicules of bone appear. 2. Within a few weeks irregularity in the density of the evulsed surface

18. Mathias, E.: Beitr. z. klin. Chir. **161**:79, 1935.
19. Fort, W. A.: Radiology **24**:96, 1935.
20. Henry, L. S.: Am. J. Roentgenol. **33**:486, 1935.

and rounding of the tuberosity are seen. 3. From six months to a year later irregular calcification and occasional cysts with loss of prominence of the tuberosity and disappearance of the sulcus are evident.

*Roentgen Examination of the Lumbosacral Articulation.*—Williams and Wigby [21] find it helpful to take a lateral view of the lumbosacral region before the anteroposterior one in order to determine the anteroposterior tilt of the sacral angle, which varies in different persons. In order to have the central ray of the tube pass between the fifth lumbar and first sacral vertebrae in taking a lateral exposure a point is chosen 2 inches (5.08 cm.) below the iliac crest and 4 inches (10.16 cm.) behind the anterior and superior iliac spine. Also the following factors require consideration: (1) superimposition of the anterior superior iliac spines, (2) elevation of the dorsal spine to eliminate sagging of the lumbar vertebral column, and (3) extension of the hips to give the true standing relation of the articulating facets.

*Lateral Roentgenography of the Neck of the Femur.*—Jones [22] describes a technic for eliminating distortion by means of a curved casette of special design which is shaped to be somewhat parallel to the curve formed by the shaft and neck of the femur. Haziness of outline has been largely removed by using a lead foil and silk filter together with a more favorable object-film distance ratio. Ability to show the head of the femur has been improved by twisting the trunk and shoulder of the patient out of the way of the x-ray tube.

### MISCELLANEOUS

*Injuries to Vertebrae and Intervertebral Disks Following Lumbar Puncture.*—An interesting report of injuries to the spine from lumbar puncture is made by Pease.[23] The findings in 12 cases are given, which show a thinning of the intervertebral disks and a definite sclerosis of the vertebral bodies due to loss of nuclear substance and irritation of the bone. Pease experimented on cadavers and found several possible terminations of the needle when it is pushed beyond the neural canal: (1) the intervertebral disk, (2) a vertebra, (3) interarticular facets, and (4) venous sinusoids in the vertebral body. Brief anatomic considerations, a description of the mechanism of production and clinical considerations including detailed reports of 3 cases with roentgenograms comprise the paper.

*Cartilaginous Inclusions in Rachitic Bones.*—McMaster [24] studied at autopsy the long bones of a child which presented evidence of healed

21. Williams, P. C., and Wigby, P. E.: Am. J. Roentgenol. **33**:511, 1935.
22. Jones, L.: Am. J. Roentgenol. **33**:504, 1935.
23. Pease, C. N.: Injuries to Vertebrae and Intervertebral Disks Following Lumbar Puncture, Am. J. Dis. Child. **49**:849 (April) 1935.
24. McMaster, P. E.: J. Bone & Joint Surg. **17**:373, 1935.

rickets and discovered epiphyseal and metaphyseal cartilaginous inclusions. Inclusions of the same type were produced experimentally in rachitic rats. Because of the persistence of such cartilaginous rests the author suggests that they may act as a source for the development of cartilaginous tumors of bone.

*Treatment of Primary Myopathies.*—A discussion based on a review of the theories concerning the production of creatine as well as its relation to the amino-acids is offered by Reese and his co-workers.[25] They stress the theory that creatine depletion secondary to nonutilized glycine in the dystrophic muscles is responsible for the disturbed physiologic process. Glycine therapy is discussed, and cases are reported. It is concluded that therapy by means of endocrine and pharmacologic stimulation has proved unsatisfactory. Therapy by glycine or glutamic acid, on the other hand, is encouraging and recommended as the best available. Clinical and biochemical investigation seems to indicate that the amino-acid therapy is effectual; cures are not obtained, but rather definite clinical remissions.

*Anomalies of Two Muscles in the Living.*—Two muscular anomalies observed in the living are reported by Sauser,[26] and the difficulties which such anomalies might present in diagnosis are discussed. The first of these anomalies was a sternal muscle which was present only on one side and presented a tumor-like swelling lateral to the lower portion of the sternum. The second anomaly was an extensor of the hand from the midportion of the distal row of carpal bones to the base of the third metacarpal bone. On contraction it appeared as a soft tumor-like mass on the dorsum of the hand. A review of the literature of these rare anomalies is given.

### CIRCULATORY DISTURBANCES OF THE EXTREMITIES

*Results of Lumbar Sympathectomy in Spontaneous Gangrene.*—Filatov[27] discusses his experience with sympathectomy in what is termed in this country "thrombo-angiitis obliterans." The immediate result in 34 patients was as follows: In 1 it was brilliant; in 16, good; in 11, satisfactory; in 5 there was no effect; 1 death occurred, following a wound infection. The end-results in 14 patients examined a year or more after operation were as follows: 9 remained well. In 2 patients seen within from one to two years after operation, some pain and tiring recurred, but no necrosis or gangrene. All of these patients maintained their hyperthermia of from 1 to 2 C. In the remaining 3 patients, the disease recurred six months, two years and three years

25. Reese, H. H.; Burns, E. M., and Rice, C. M: Treatment for Primary Myopathies, Arch. Neurol. & Psychiat. **33**:19 (Jan.) 1935.

26. Sauser, G.: Wien. klin. Wchnschr. **48**:430, 1935.

27. Filatov, A.: Deutsche Ztschr. f. Chir. **244**:491, 1935.

after operation but there was no gangrene (a fact the author attributes to the operation). The author emphasizes that the indications of Adson and Brown (demonstration that the vessels are still capable of dilatation, as measured by comparison of the temperatures of the extremity and the body) should be followed.

### ORTHOPEDIC OPERATIONS

*Arthrodesis for Tuberculosis of the Hip.*—Harris [28] uses a combined intra-articular and extra-articular method of hip fusion for tuberculosis, using a large rectangular flap of ilium and securing it with bone screws to the superior rim of the acetabulum and to the denuded neck of the femur. Of 22 operations performed by this method, 16 obtained bony union; in 4 additional cases the condition was greatly improved; 1 patient died of postoperative pulmonary embolism; in another the hip was still in plaster fixation.

*Closure of Cavities from Chronic Osteomyelitis by Plastic Methods.*—In cases of long-standing osteomyelitis of long bones, Lord [29] advocated the removal of the diseased bone and the introduction of fat, fascia and muscle tissue into the cavity, with primary loose closure of the skin flap. A Dakin tube is usually brought out at each end of the wound. He states that in some cases complete closure and healing of the wound have been accomplished in two weeks. Illustrative cases are described, and the operative technic outlined.

*Treatment of Pseudo-Arthrosis of the Long Bones with a Rib Transplant.*—Brewer [30] advocates the use of rib grafts instead of the tibial grafts in the repair of pseudo-arthroses. He removes one, two or even three ribs in the region between the anterior axillary and mammary lines. The ribs are removed together with the periosteum. He overlaps the site of the fracture for 2 cm. and holds the ribs against the site of fracture with the aid of a metallic wire above and below. The ribs are split lengthwise on one side and opened up, like a book, before being applied to their bed. Three cases are reported with satisfactory union.

EDITORIAL NOTE.—This procedure has been utilized for the clavicle with some success. However, tibial or iliac grafts for routine use seem easier to obtain and shape and seem to be more adequate in size, and with them metallic fixation is not required.

*Therapy of Epicondylitis Humeri (Tennis Elbow).*—Since the muscles arising from the external epicondyle are involved in the symp-

28. Harris, R. I.: J. Bone & Joint Surg. **17**:318, 1935.
29. Lord, J. P.: Surg., Gynec. & Obst. **60**:853, 1935.
30. Brewer, F.: Deutsche Ztschr. f. Chir. **244**:445, 1935.

tomatology of epicondylitis humeri, Parker [31] divides their insertion from the epicondyle through a 3 cm. incision. He then modifies this procedure by performing the myotomy subcutaneously through a puncture wound. His deep incision is about 2 cm. long and divides the extensors of the hand. During the myotomy a position of 145 degrees of extension and full supination of the forearm are maintained. He states that the result is uniformly good. He immobilizes the arm for six days.

EDITORIAL NOTE.—This procedure has given satisfaction in 3 cases for 1 of the editors. The early mobilization advised by Parker may bear checking with experience.

*Operative Treatment of Syringomyelia.*—An evaluation of the end-results of operative evacuation of the cysts of the spinal cord in syringomyelia was undertaken by Juželevskij [32] on the basis of his own experience and that recorded in medical literature. He had operated on 23 patients, of whom 16 could be followed adequately. The immediate results (based on his 23 cases and 81 gathered from the literature) were good, although by no means brilliant. The end-results indicated that the disease ran its course uninfluenced by the operation. He therefore advises against its use on the basis of his own experience, despite his own encouraging report five years ago. Incidentally he measured the pressure within the cysts before evacuation, and found no evidence that there was increased pressure which required release. Five of his patients received roentgen therapy (dosage not given) without effect.

EDITORIAL NOTE.—The paper is an honest summary of the surgical aspects of the problem by an author of unusual experience in syringomyelia. At present physical therapy to conserve muscular strength and support to prevent deformities, possibly with irradiation of the spine, seem to be the best therapeutic measures available.

*Nerve Section in Neuralgia in Amputation Stumps.*—Suggesting as a hypothesis that some imbalance in cutaneous innervation follows amputation, Molatkof [33] studied, on a small group of painful stumps, the effect of division of the cutaneous nerves on the projected pain. His results as described were encouraging and appear to merit careful consideration. For pain projected to the inner malleolus and medial border of the foot, he advised division of the obturator nerve at the level of Poupart's ligament. For pain referred to the external malleolus and heel he divided the lateral femoral cutaneous nerve. In the upper extremity, for pain projected into the absent thumb, index and middle fingers he divided the lateral antebrachial cutaneous nerve. He

31. Parker, H.: München. med. Wchnschr. **82**:246, 1935.
32. Juželevskij, A.: Deutsche Ztschr. f. Chir. **244**:503, 1935.
33. Molatkof, A. G.: Arch. f. klin. Chir. **181**:515, 1935.

states that these operations were helpful if the amputations were below the middle of the lower third of the lower part of the leg or the upper third of the forearm.

*Permanent Extirpation of the Nails in Chronic Onychomycosis.*—According to Taylor,[34] topical treatment of chronic fungous infection of the entire toe-nail seldom effects permanent cure, and irradiation of the nail with x-rays is dangerous. Permanent ablation of chronically infected toe-nails is feasible, assures cure with a minimum of after-care, and is recommended as the most effective treatment. The details of the operation, under local anesthesia, are described.

### FRACTURES

*Treatment of Fractures of the Spine Unaccompanied by Lesions of the Cord.*—Rogers[35] made a careful study of 31 cases of fracture of the vertebral bodies with the end-results obtained. These fractures were all treated by immediate reduction on the hyperextension frame previously described by him.[36] The cases of closed reduction were all carefully followed by roentgenograms. In 96 per cent of the cases the narrowing of the vertebral body was completely overcome. On the other hand, fractures complicated by dislocation were completely reduced in only 40 per cent of the cases. Study of roentgenograms taken at intervals after the reduction revealed that part of the correction obtained was lost through the ultimate gradual narrowing of the injured intervertebral disk. The correction was also lost in certain cases through inadequate fixation. Bony union across the fracture line apparently occurred in all cases, and he feels that union was fully adequate in from two to seven months. The only risk of injury to the spinal cord during hyperextension is in cases of fracture and dislocation, and the risk in these cases is slight if proper precautions are observed. In 42 per cent of the cases there was bridging by bone across the injured intervertebral disk, accomplishing fusion between two adjacent vertebral bodies. This occurred as early as four months and as late as four and one-half years after injury. Early spinal fusion is indicated in cases of fracture and dislocation which cannot be completely reduced. In cases of simple compression of the vertebral body without dislocation, spinal fusion may be necessary late if there is persistent pain due to structural alteration and poor body mechanics. In this series of cases 65 per cent of the patients returned to preinjury occupation and activity and remained free from pain. The average

34. Taylor, K. P. A.: Am. J. Surg. **27**:145, 1935.

35. Rogers, W. A.: Treatment of Fractures of Vertebral Bodies Uncomplicated by Lesions of the Cord, Arch. Surg. **30**:284 (Feb.) 1935.

36. Rogers, W. A.: Surg., Gynec. & Obst. **50**:101, 1930.

period of disability was eight and one-third months, and the longest was fourteen months. Five patients failed to return to preinjury activity.

EDITORIAL NOTE.—This article describes fully the pathologic changes in vertebral fractures and the resultant injury to the intervertebral disks and vertebral bodies. The details of reduction by hyperextension are carefully outlined, and the end-results obtained from this type of treatment are shown to be excellent. The article should be read in its entirety by all who are treating such fractures.

*Fractures and Dislocations of the Cervical Spine.*—From a study of 45 fractures or dislocations of the cervical spine, Hudson [37] concludes that conservative measures, i. e., traction on the head followed by immobilization in the plaster of paris cast, gave the best results. No laminectomies or spinal fusions were performed in this series. Fractures of the fifth and sixth cervical vertebrae were the most common, and the transverse processes, odontoid process, spinous processes, laminae and pedicles were injured in that order of frequency. There were 4 unilateral dislocations of the atlas on the axis. These were reduced by manipulation under general anesthesia. The author thinks that the patients with immediate signs of complete paralysis have a hopeless outlook for recovery. Those with no evidence of injury of the cord have an excellent chance for recovery, whereas those with incomplete or delayed injury of the cord have a fair chance for recovery. In his series of 45 cases there were 6 deaths.

*Pathologic Study of Fracture of the Femoral Neck After Treatment with the Smith-Petersen Nail.*—Nystrom [38] of Uppsala reports the results of 29 operations by use of the Smith-Petersen nail for fractures of the femoral neck. Three patients died a short time postoperatively. In 24 patients good reduction was obtained. In 6 patients a separation of the fragments was observed during convalescence which would probably go on to nonunion. In several cases the nail bent or broke, probably from too early weight bearing. The author feels that the method is of help in permitting patients to move about more freely in bed, but that weight bearing should be delayed for at least two months.

*Fractures of the Femoral Neck Treated by Blind Nailing.*—O'Meara [39] reports 12 cases of fracture of the femoral neck, 11 transcervical and 1 at the base treated by "blind nailing" with a flanged nail. Under anesthesia the fracture was reduced by manipulation. Anteroposterior and lateral roentgenograms were then taken. If satisfactory

37. Hudson, O. W.: J. Bone & Joint Surg. **17**:324, 1935.
38. Nystrom, G.: Acta chir. Scandinav. **76**:1, 1935.
39. O'Meara, J. W.: New England J. Med. **212**:43, 1935.

reduction had been obtained, a 3 to 4 inch (7.6 to 10 cm.) incision was made on the lateral side of the thigh distal to the greater trochanter and a Smith-Petersen nail was driven from below the trochanter into the femoral neck. The angle of insertion and the length of the nail were determined with a protractor on the anteroposterior roentgenograms. After the nail had been driven half-way into the femoral neck roentgenograms were taken again; and if the direction and position of the nail were satisfactory, the nail was driven full length into the bone. The leg was kept in a Thomas splint with 5 pounds (2.3 Kg.) of traction for from three to four weeks. Weight bearing on the leg was permitted after two months. No walking caliper was used. The nail was removed in each case after six months. The study of the end-results showed that 9 patients were bearing weight. Seven in whom the nail had been removed had bony union. One patient died of carcinoma. Two were treated too recently for a study of end-results to be made.

*Crushing of One Tuberosity of the Tibia.*—Sechehaye [40] reports 14 cases of unilateral crushing of the upper end of the tibia in which the injury was treated by operative means and 6 cases in which it was treated by closed methods. Roentgenologic tracings are given in all cases. The operative treatment was much more successful and consisted in levering up the depressed condyle, after opening the joint so as to restore, under direct vision, the contour of the articular cartilage, and supporting the replaced fragments with a bone graft driven horizontally and acting as a supporting shelf. If the semilunar cartilage was damaged, as it frequently was, it was removed.

*Treatment of High Tibial Fractures Extending into the Knee Joint.*—Kummer [41] advises, in cases of true oblique fracture of one or the other condyle of the tibia with malalinement of the joint, that the fractured portion be elevated into position and transfixed with an autogenous bone graft obtained from the same tibia. He reports 3 such cases, in which he used the graft rather than metal appliances. His cases had approximately one year's follow-up. He attempts a comparison of his group of fractures with a group of 15 treated conservatively. Of the latter, 11 showed arthritis deformans (duration after fracture not stated). He believes the operative procedure to be of value in averting such changes.

*Epiphyseal Fracture and Dislocation at the Elbow Joint.*—Howard [42] found that separation of the lower humeral epiphysis with dislocation of the epiphysis (capitellum and trochlea or capitellum alone)

40. Sechehaye, L.: J. de chir. **45**:561, 1935.
41. Kummer, A.: Zentralbl. f. Chir. **62**:503, 1935.
42. Howard, N. J.: J. Bone & Joint Surg. **17**:123, 1935.

occurred in 7.2 per cent of injuries to the elbow. There is danger of overlooking the element of dislocation and treating the injury simply as an epiphyseal separation. Closed reduction is difficult, and operation is often necessary. Reduction when incomplete is followed by extreme loss of function.

*End-Results of Fractures of the Distal Radial Epiphysis.*—Aitken [43] studied the clinical and roentgenologic end-results in 60 cases of injury to the lower radial epiphysis at periods ranging from two to nine years after injury. He found surprisingly little deformity and very slight interference with growth resulting from such injury. In 34 cases the reduction of the displaced epiphysis was not accurate, yet in none of the cases was there any deformity even if the final displacement amounted to one quarter or one half of the thickness of the shaft. Repeated manipulations seemed to have no bad effect on the end-result. Because malposition was a rare end-result, he feels that osteotomy is never justified.

*Fractures of the Forearm.*—Hein [44] presents a complete review of 415 fractures of the forearm of all types including fractures of the upper and lower ends as well as of the shaft. Good results were obtained in 87 per cent of the cases. Nonunion occurred in only 7 per cent of the cases. Union was less rapid in patients operated on than in those treated by closed reduction.

EDITORIAL NOTE.—The article gives a comprehensive review of the subject of forearm fractures and is well worth reading.

*Fractures of the Wrist in Childhood, Puberty and Adolescence.*—Gillies [45] concludes that before closure of the epiphyseal line age bears an important relationship to the type of fracture that occurs. In childhood the characteristic fractures are either transverse or "torus" (the so-called garden hose type). At puberty the typical injury is separation of the epiphysis with posterior displacement.

*Healing of Phalangeal Fractures.*—In 100 consecutive cases Smith and Rider [46] found that the average time for bony healing of complete phalangeal fractures, as determined roentgenologically, was five months. Clinical healing took about one quarter of this time or about five weeks and was considered as embracing the period that elapsed from the time of the injury to that of the return to the former occupation. Fracture lines were usually more distinct at the end of thirty days than at the time of injury. Lack of bony union could not be assumed until at

43. Aitken, A. P.: J. Bone & Joint Surg. **17**:302, 1935.
44. Hein, B. J.: J. Bone & Joint Surg. **17**:272, 1935.
45. Gillies, C. L.: Iowa State J. Med. **25**:15, 1935.
46. Smith, F. L., and Rider, D. L.: J. Bone & Joint Surg. **17**:91, 1935.

least a year's time had elapsed. Splints were kept on about two weeks except in cases of "baseball finger," in which the injured member was splinted longer.

## RESEARCH

*Stimulation of Healing in Nonhealing Wounds by Allantoin.*—Robinson [47] ascertained that allantoin is an important excretory product of the maggot. He believes that it is responsible for at least some of the beneficial effect of maggots on septic wounds. It is not claimed that allantoin may entirely replace the maggot, because the maggot, in addition to secreting allantoin, has the ability to carry off detritus. Allantoin, however, is bland, stable and harmless, can be obtained at rather low cost and stimulates healing of wounds.

*Experimental and Clinical Study of Traumatic and Hemorrhagic Shock.*—Coonse and his co-workers [48] show by numerous charts from observations and studies on experimental animals that traumatic differs from hemorrhagic shock in that the former is characterized by increasing acidosis and a relative increase of blood cells over blood serum, the latter by a lack of acidosis and a relative increase of serum over blood cells. In slow hemorrhage, however, the findings more clearly resemble those of traumatic shock and usually show depression of the higher centers, increasing anoxemia of tissue and acidosis. Laked blood and traumatized muscle seem to be factors which produce the toxic and depressant effect on the vital centers. Hemolysis is constantly found in traumatic shock. Acute hemorrhagic shock is best treated by replacement of the lost volume of blood with whole blood or with intravenous saline, dextrose or acacia solution. Traumatic shock, on the other hand, responds favorably to intravenous 5 per cent sodium bicarbonate solution, usually about 40 cc. This can be repeated every half hour or at longer intervals. Such treatment seems to prevent acidosis, serves as a stimulant to the vital centers, increases the rate of dissociation of oxyhemoglobin and improves the peripheral blood flow. In certain cases supplementary inhalations of carbon dioxide and oxygen may be helpful for mechanical effects. Summaries of the records on observations in 7 clinical cases are appended which show the results of the alkaline therapy.

*Repair of Articular Cartilage in Young Dogs.*—Bennett and Bauer [49] compared the reparative changes in surgical defects of the central non-weight-bearing articular cartilage of the knee joint of the puppy with the changes in similar lesions in the adult dog previously reported.[50]

47. Robinson, W.: J. Bone & Joint Surg. **17**:267, 1935.

48. Coonse, G. K.; Foisie, P. S.; Robertson, H. F., and Aufranc, O. E.: New England J. Med. **212**:647, 1935.

49. Bennett, G. A., and Bauer, W.: J. Bone & Joint Surg. **17**:141, 1935.

50. Bauer, W., and Bennett, G. A.: Am. J. Path. **8**:499, 1932.

These studies indicated that repair is no more rapid or complete in young puppies before closure of the epiphysis than it is in adult dogs. The proliferative activity of cartilage cells is greater in the deeper zones of the articular cartilage than in the more superficial zones. More active proliferation of cartilage cells was noted in lesions in which crevices existed.

*Increase of Neuromuscular Function in Partial Nerve Paralyses.*—Dogliotti [51] has found that if a nerve is sectioned the regenerating fibers multiply themselves considerably. On this assumption he believes that if a nerve is partially paralyzed (as after poliomyelitis) it can be sectioned and immediately sutured together again and the few vital nerve fibers will regenerate and multiply themselves, sending down the distal portion of the nerve many functioning fibers where before there were only a few. In dogs two thirds of the sciatic nerve was sectioned, dissected upward and side-tracked into muscle tissue. The remaining third of the nerve above was attached to the whole trunk below. Section was done at this point and the third of the trunk resectioned to the whole nerve below immediately. Complete paralysis of the limb naturally followed, but after from six to seven months there was normal use of the whole limb in spite of the fact that two thirds of the nerve was not functioning. Microscopic section showed that the upper nerve fibers had regenerated in such number that numerous branches had grown down and filled the whole trunk of the nerve. Section and suture were then done in a patient who had complete poliomyelitic paralysis of one leg except for slight flexion of the third, fourth and fifth toes, a trace of plantar flexion and a possible trace of contraction of the triceps (gastrocnemius?). This patient had been paralyzed for eight years. Fifteen months after operation the patient had a return of the power of flexion of all the toes. Four years later there was, in addition, power in the posterior muscles of the calf and thigh. There were flexion of the knee, extension of the ankle and flexion of all the toes.

EDITORIAL NOTE.—Function of the knee, ankle and toes is described as *balide*, or healthy. How strong a function this represents we do not know.

51. Dogliotti, A. M.: J. de chir. **45**:30, 1935.